# EGYPT

THE EGYPTIAN SOCIETY OF
RADIOLOGY AND NUCLEAR MEDICINE

Delta University
for Science and Technology
جامعة الدلتا للعلوم والتكنولوجيا

# ,Pulmonary clinical imaging guidelines common pattern and debates

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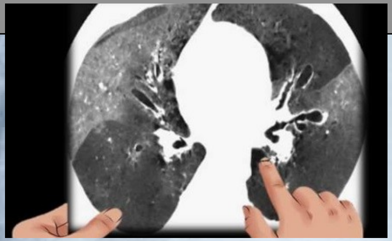
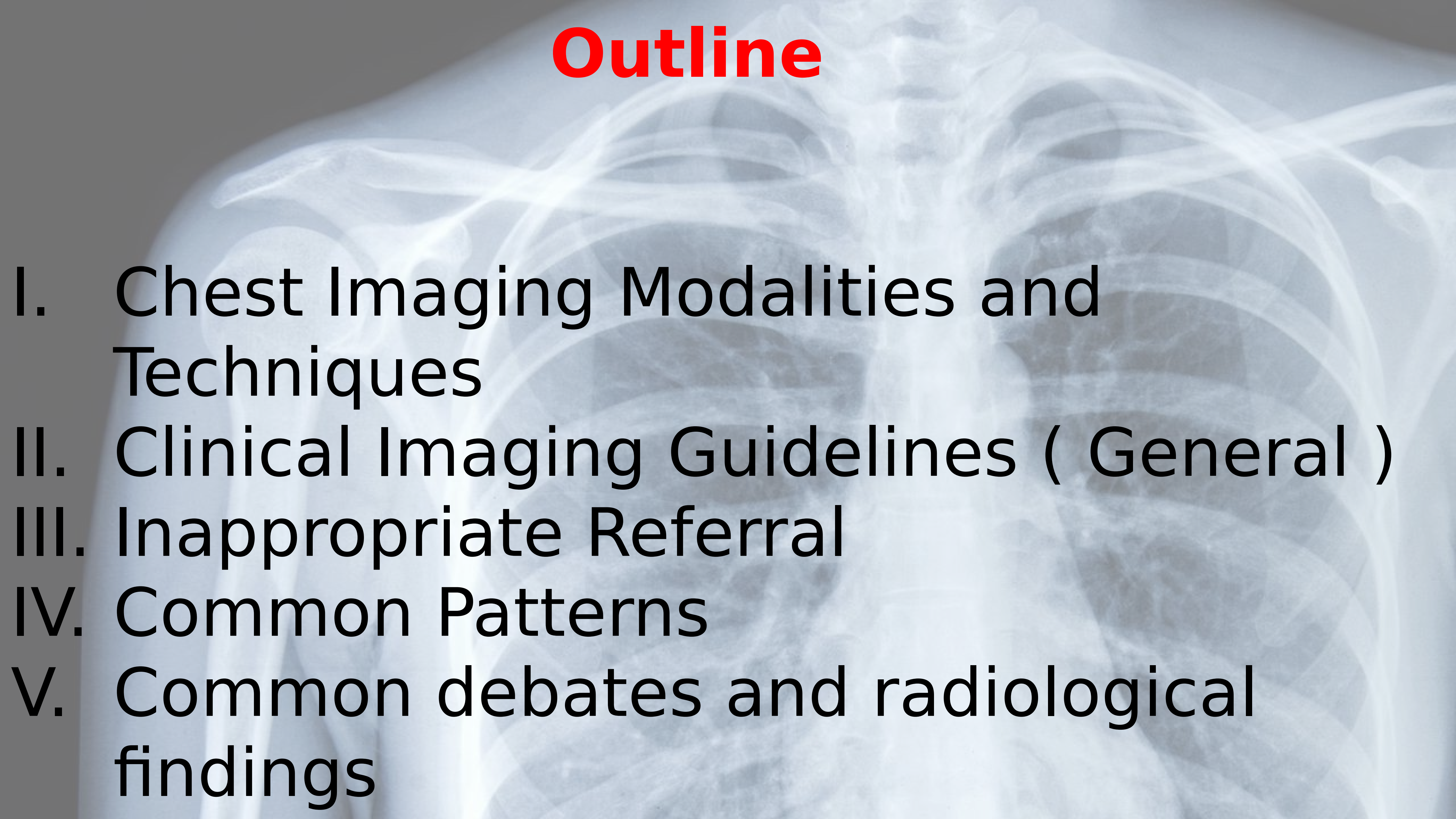


# Outline



I. Chest Imaging Modalities and Techniques
II. Clinical Imaging Guidelines ( General )
III. Inappropriate Referral
IV. Common Patterns
V. Common debates and radiological findings

# I. Chest imaging modalities and techniques

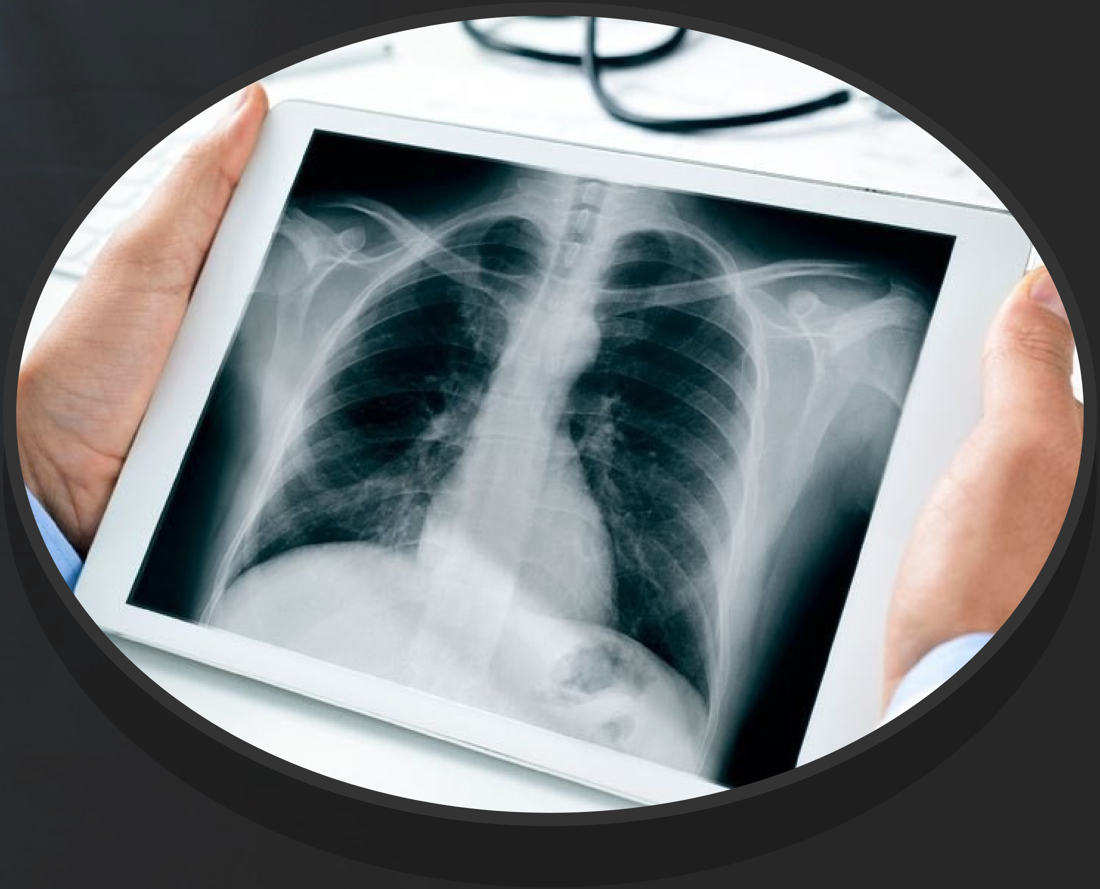
# Imaging Modalities

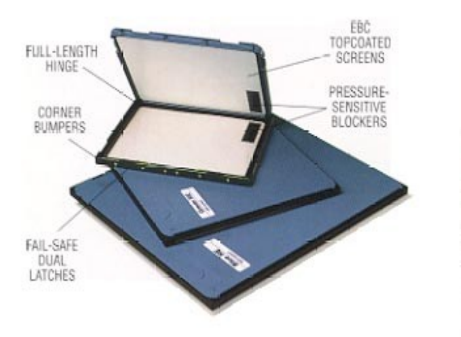
1. X-ray ( conventional, CR, DR )
2. Ultrasound(US)
3. Computed Tomography(CT)
4. Magnetic Resonance Imaging (MRI)
5. Nuclear medicine (Planner - SPECT – PET)
6. Hybrid imaging (SPECT-CT / PET-CT / PET-MRI)
7. Imaging guided Intervention (diagnostic/therapeutic).

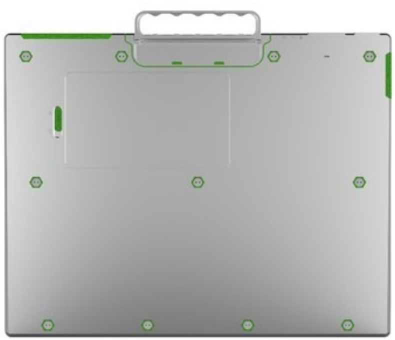
**Radiology 1895**

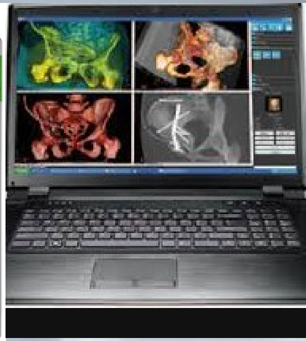
**Radiology 2020**

# 1. x-ray ( conventional-CR- DR )





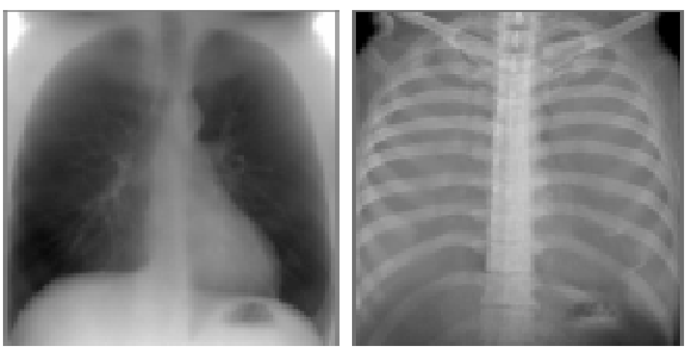


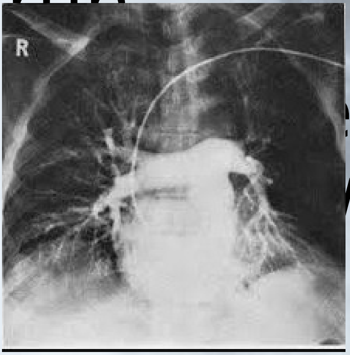


- Conventional x-rays (screen/film radiography) are attenuated within the body and activate the film to emit light rays and image is produced.
- Computed Radiography (CR): film receptor is replaced by reusable plate.
- Digital radiology (DR) replaced by transistors.
- Displayed on a monitor  to be evaluated before patient leave then printed
- No dark room or chemicals - no need for a space to store films – no need to change your old x-ray machine.

# ADVANTAGES OF CR/DR

- Better quality
- Changes made to image after the exposure (post processing ) could display tissue or bone image, eliminate need to repeat the exposure
- Storage & digital archiving : Retrieval of images ( if radiograph is lost) and allow others to review the images , **PACS** ( picture archiving and communication system), **Tele-radiology** – (long distance transmission of image information)
- Less radiation dose and infection transmission ( could be paperless )
- Economic advantage – at least in the long run
- DR is more expensiv er i ewing ( wire or wireless) and better c nt workflow or mass chest x-ray exa

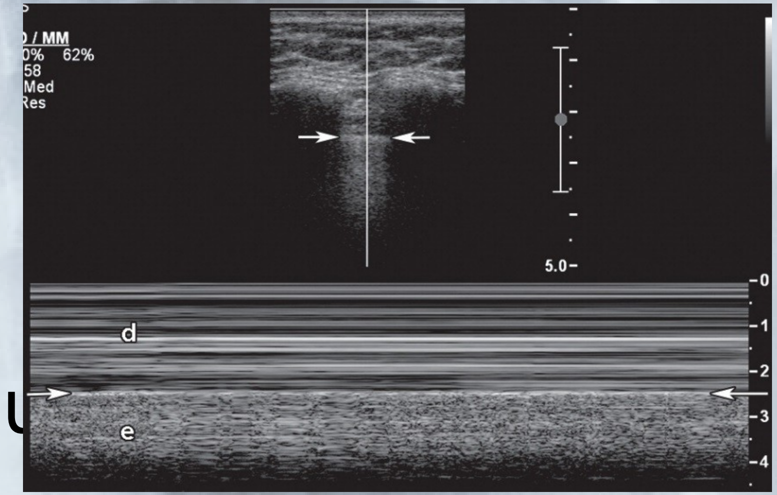




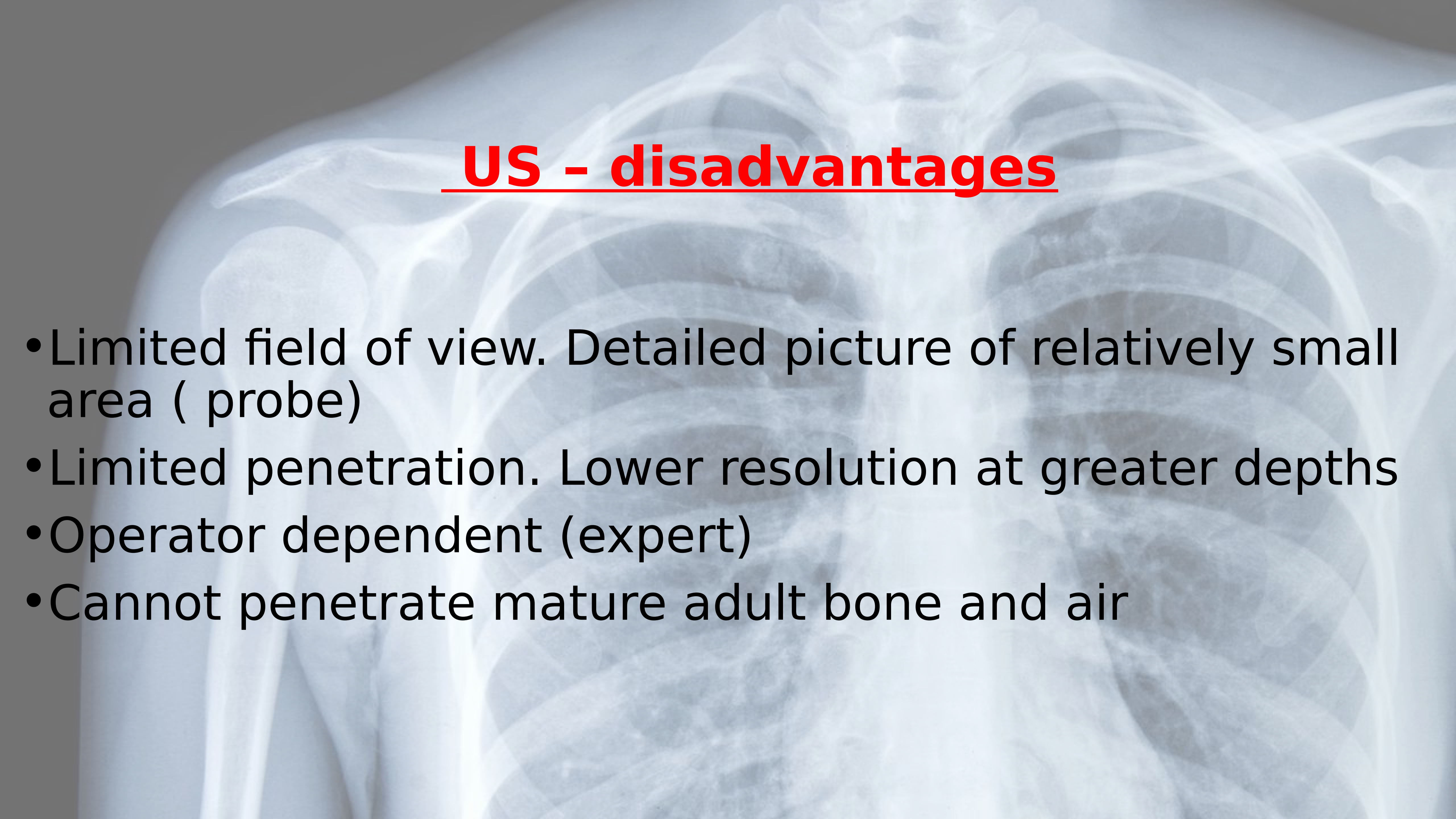
# Ultrasound -2

# US -ADVANTAGES

- High resolution for superficial structure and Doppler Scanning
- Ability to image in real-time = hands-on, dynamic, fast
- Interactive –allows feedback from patient
- Generally unaffected by metal artifacts
- No radiation to patient or provider
- Exam of contralateral side for comparison
- Real-time guidance for interventional procedu
- Portable
- Relatively inexpensive
- Educational facility (anatomy , technique , interpretation)



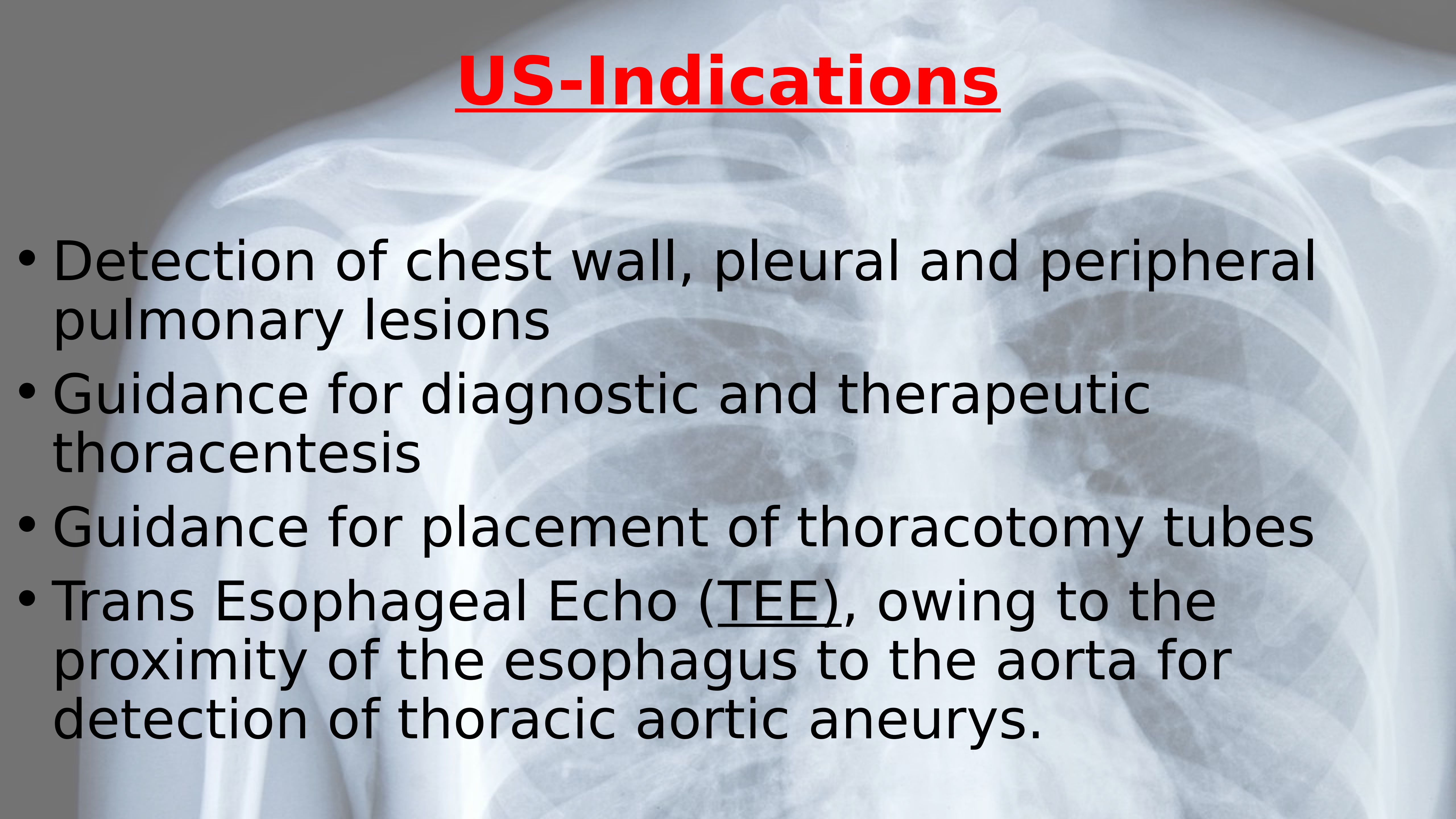
Normal lung and pleura US. Note the pleural line (between arrows). **(a)** Sagittal B-mode US image shows the bat sign. *a* = subcutaneous fat, *b* = muscles, *c* = ribs. **(b)** Sagittal M-mode US image shows the seashore sign. *d* = static thoracic wall, *e* = granular pattern of the lung. **(c)** Sagittal power Doppler US image shows the power



# US – disadvantages

- Limited field of view. Detailed picture of relatively small area ( probe)
- Limited penetration. Lower resolution at greater depths
- Operator dependent (expert)
- Cannot penetrate mature adult bone and air

# US-Indications



- Detection of chest wall, pleural and peripheral pulmonary lesions
- Guidance for diagnostic and therapeutic thoracentesis
- Guidance for placement of thoracotomy tubes
- Trans Esophageal Echo (TEE), owing to the proximity of the esophagus to the aorta for detection of thoracic aortic aneurys.

# Computed Tomography (X-RAY) -3

# CT

- Advantages:

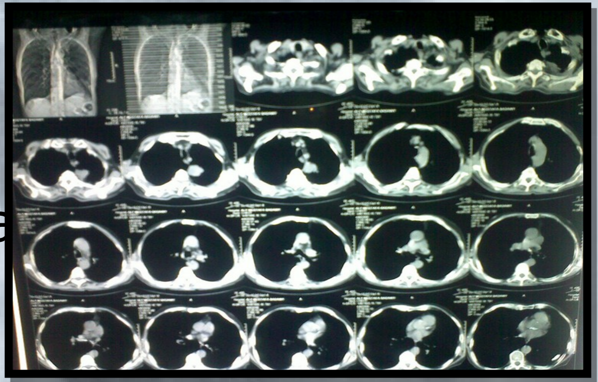
✓ Relatively quick imaging procedures.

✓ Requires minimal patient cooperation.

✓ Offers excellent anatomic detail of the thorax, including lung parenchyma, airways, vasculature and chest wall.

✓ CT has high sensitivity for detection of different densities (Air -400 / fat -200 / water 0 / thick fluid 10 /soft tissue 40 /blood 70 / contrast medium 100 /bone 200)

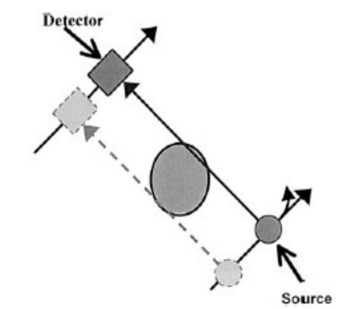
- Disadvantages:
  - Exposes the patient to a large amount of ionizing radiation.
  - Exposes the patient to the risk of contrast induced nephropathy and a

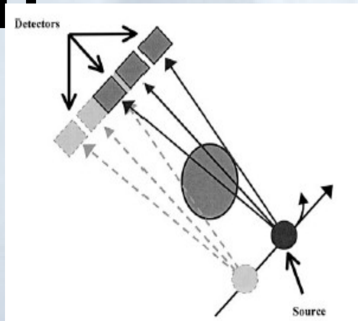


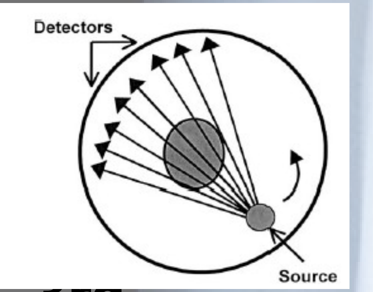
# CT EVOLUTIONS (7 GENERATIONS)

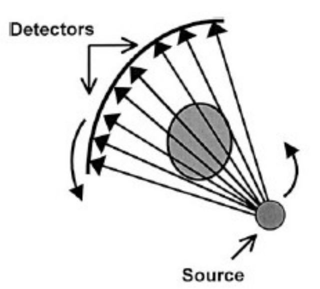
1970

Conventional

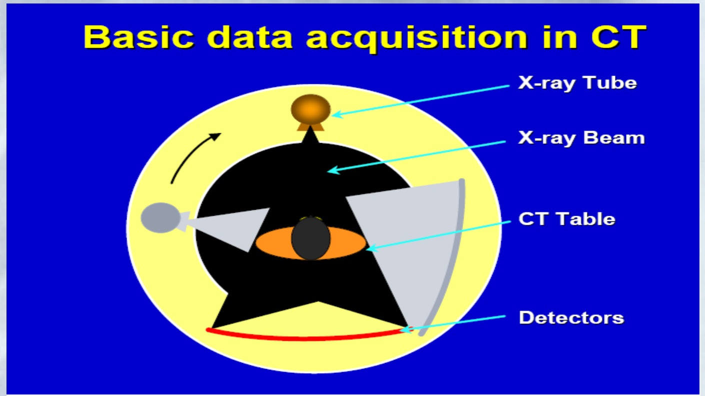








3rd

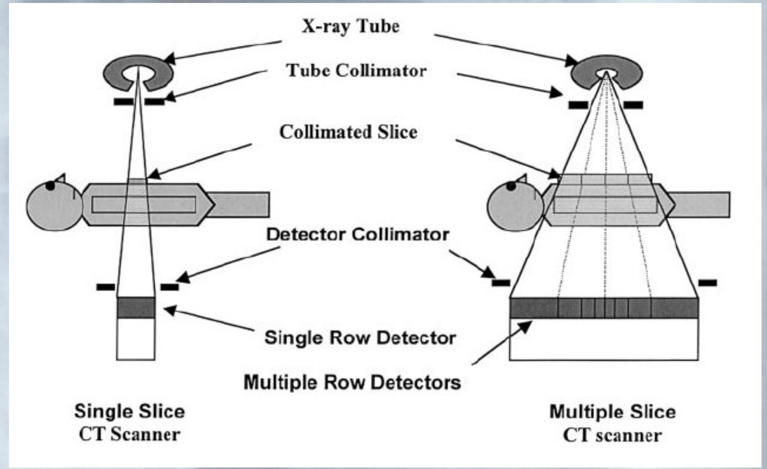


1990

Spiral

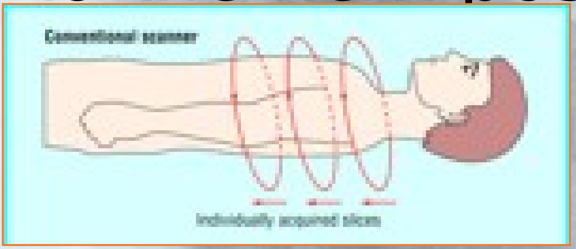
1995

Multi-slice



# CONVENTIONAL CT

After each rotation the scanner must stop and rotate in the opposite direction and the table transit to the next position .



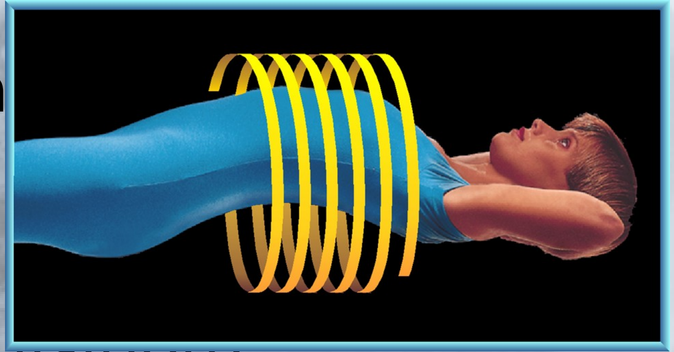
## LIMITATIONS

- Slow scan time, that  prone to artifact caused by movement or breathing.
- Poor ability to reformat images in different planes.
- Dynamic contrast studies are less accurate .
- Small lesions between slices can be missed.
- Could repeat scanning of the same level due to variable inspiratory effort (missing a small lesion).

# Spiral (Volumetric) multi-slice ct Scanning

Continuous data acquisition during gantry rotation and patient table displacement at constant speed

## BENEFITS



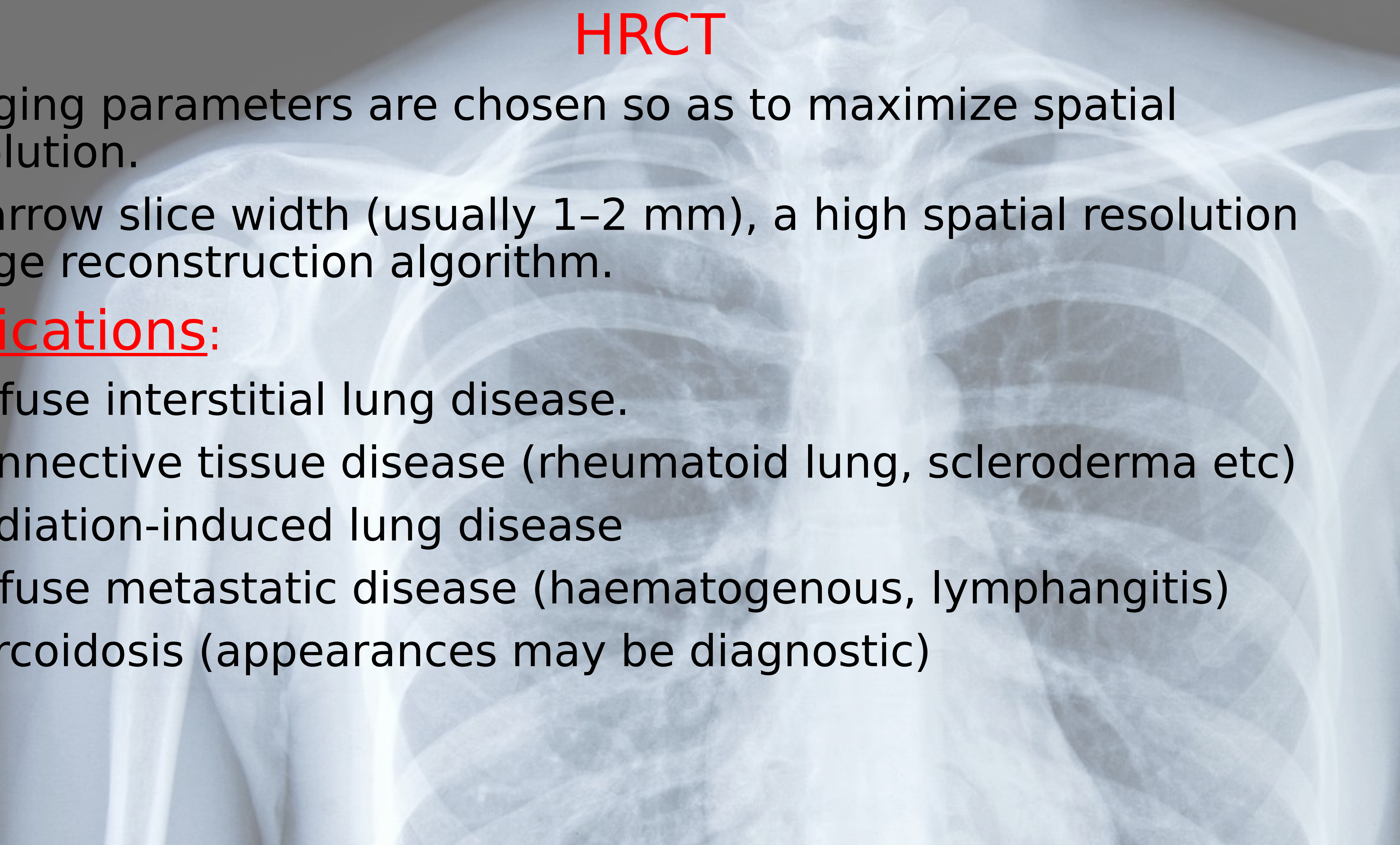
- Alter Slice Thickness Retrospectively Without Resca
  - Image Signal to Noise Ratio
  - Filming Costs (Scan 2mm, Film 5 mm)
- Reduced Examination Time (Single breath-hold acquisition):

  No lesion missed, 94% of patients can hold their breath for 30 sec
- Good control of delay between injection and scan:

  Study performed within a desired blood phase (Multi-phasic studies )

  Efficient use of contrast material
- Longer Scans (Full Organ Coverage in Multi Vascular Phases - Trauma Patient whole body - Long Vascular Run off)

# HRCT

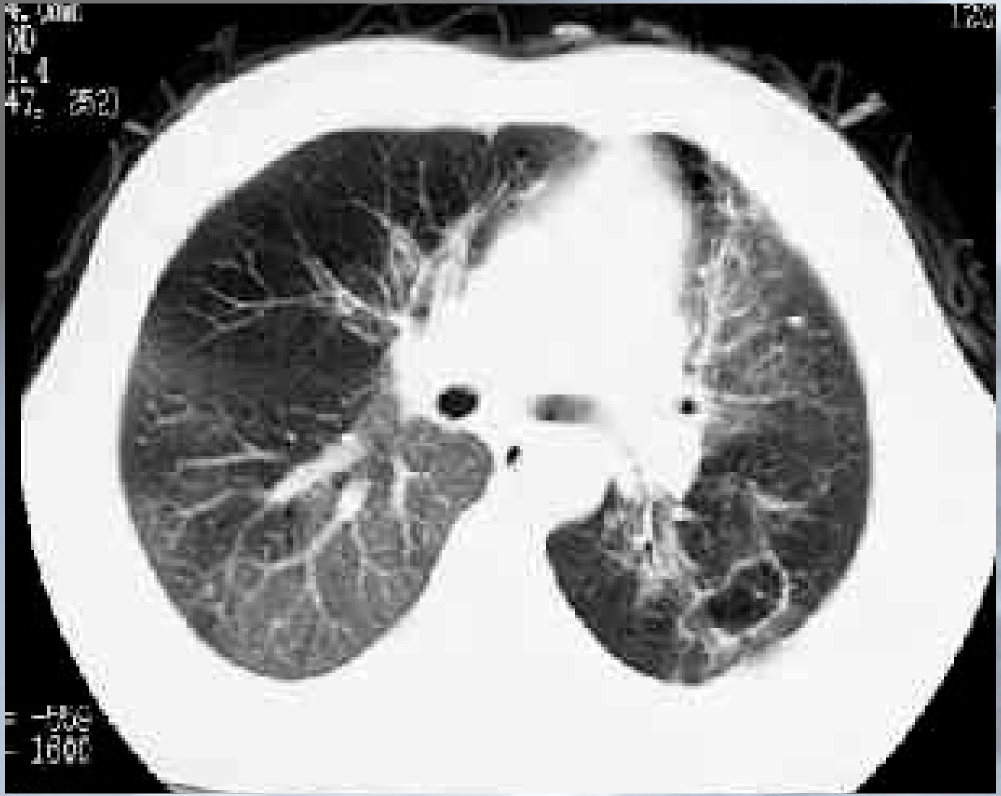


imaging parameters are chosen so as to maximize spatial resolution.

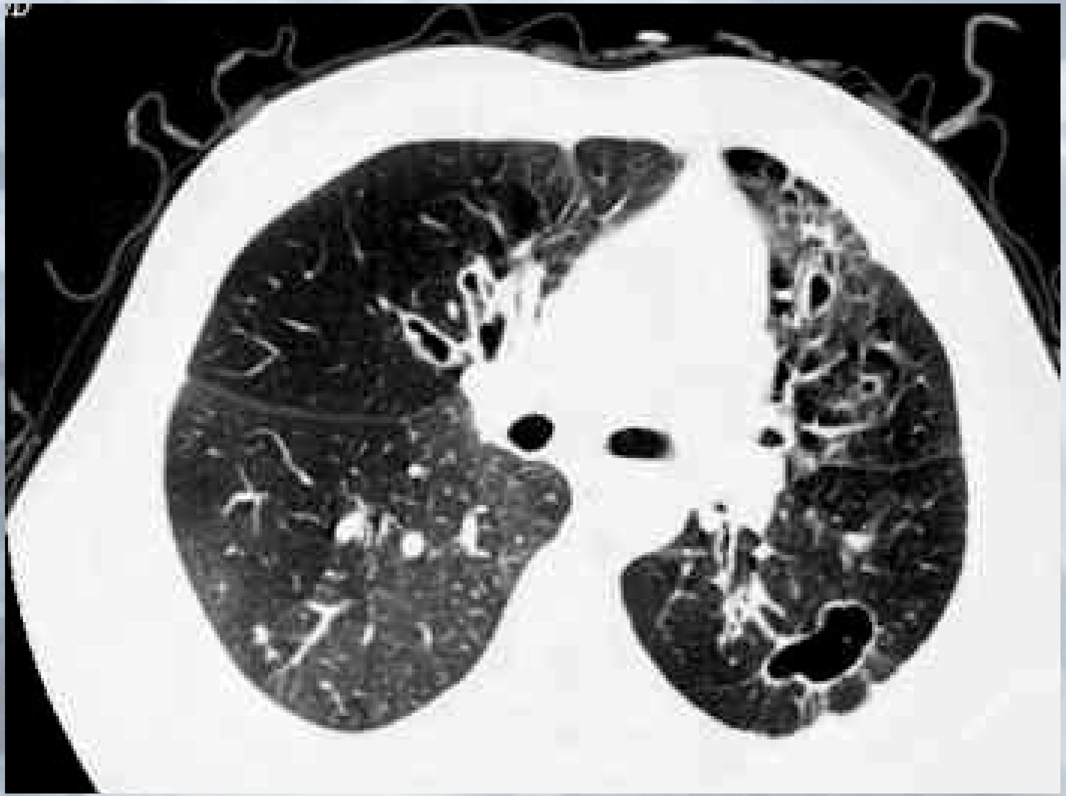
A narrow slice width (usually 1–2 mm), a high spatial resolution image reconstruction algorithm.

## Indications:

- Diffuse interstitial lung disease.
- Connective tissue disease (rheumatoid lung, scleroderma etc)
- Radiation-induced lung disease
- Diffuse metastatic disease (haematogenous, lymphangitis)
- Sarcoidosis (appearances may be diagnostic)



Standard CT



High Resolution CT,HRCT

# Contrast injection

**Indications**

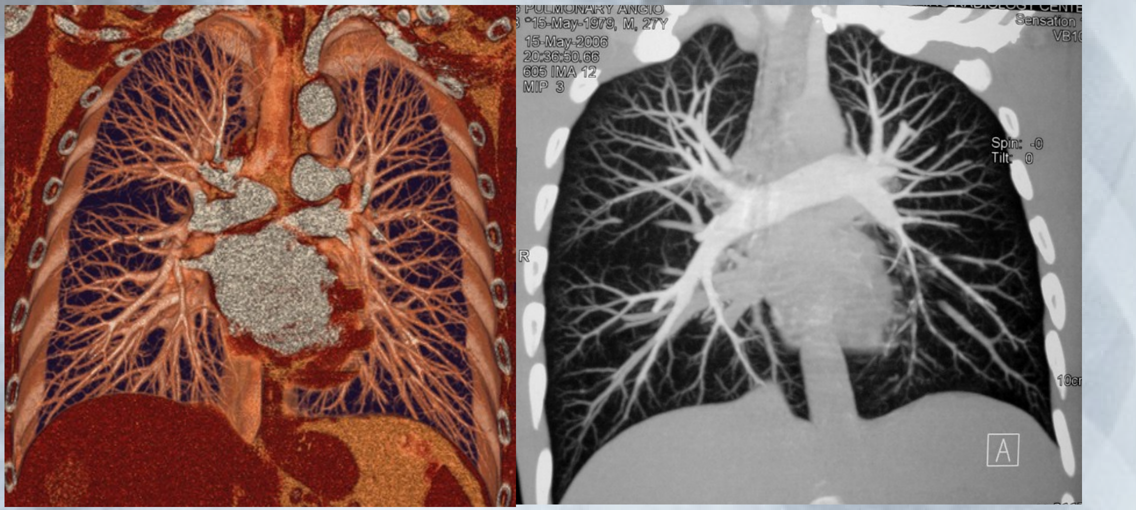
- pulmonary angiography (pulmonary embolism and AVM)

Perihilar and mediastinal lesions -

- **Not indicated**

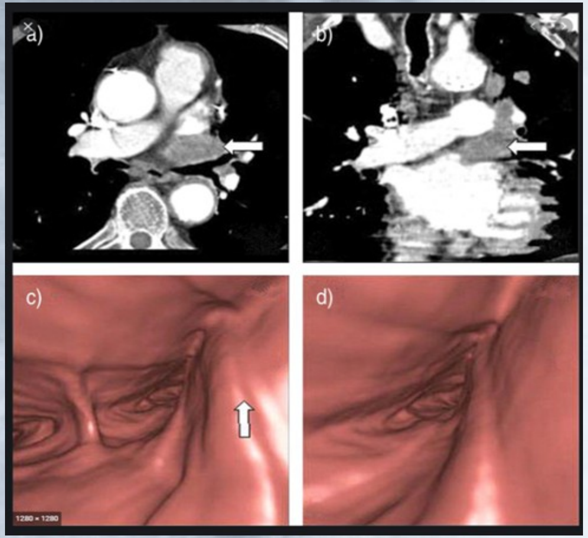
- Diffuse lung disease.
- Bronchiectasis
- Screening for lung deposits
- Some cases of trauma.

Normal pulmonary vascularity



# Virtual bronchography

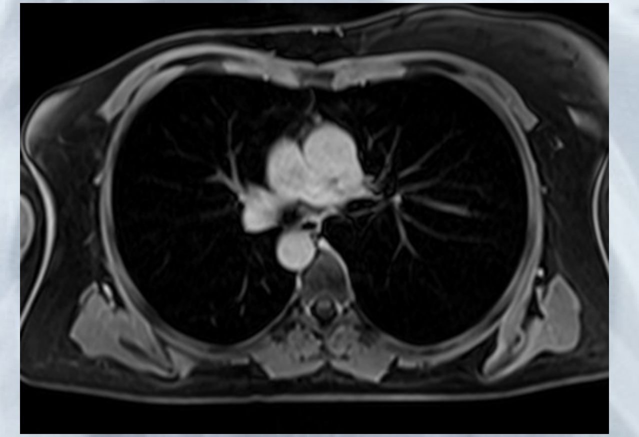
- Virtual bronchoscopy is the descriptive term given to representations of the bronchial tree and surrounding structures created from spatial information derived from 3D reformatting other than the bronchoscope which is an invasive procedure .



# Magnetic Resonance Imaging -4

# MRI

Advantages:



- ✓ No irradiation
- ✓ Variable sequences.
- ✓ Direct multiple planes ( without reformatting )
- ✓ Excellent for chest wall soft tissue imaging
- ✓ Excellent for bone marrow imaging
- ✓ characterize mediastinal lesions seen by other imaging modalities
- ✓ Angiography could be done without contrast injection

Disadvantages:

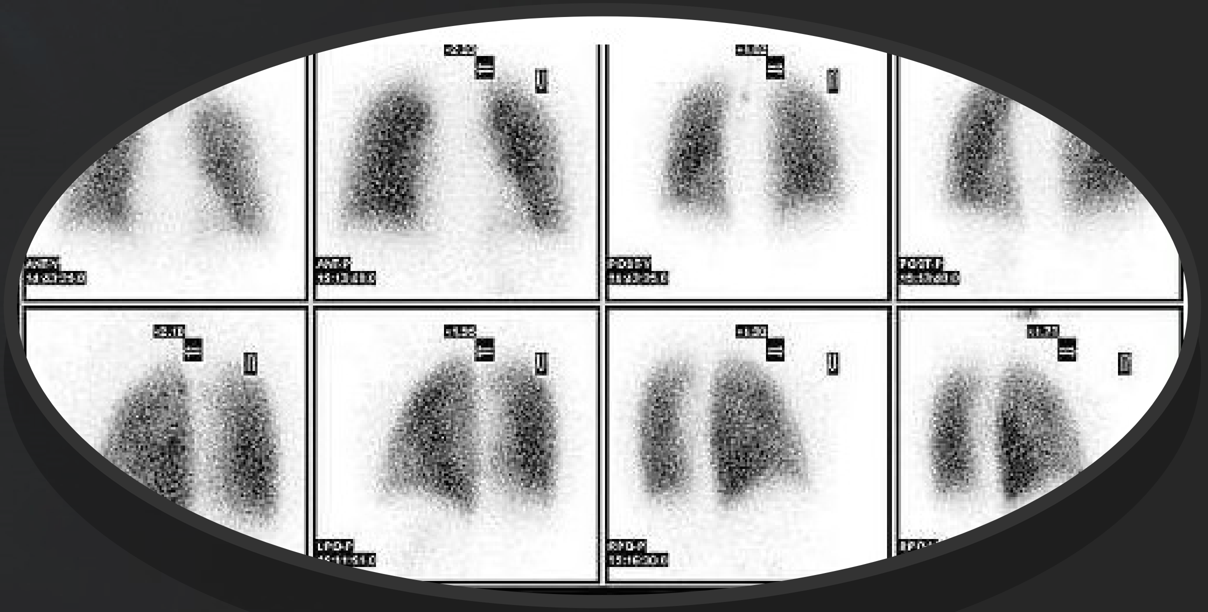
- ✓ Longer time not suitable for uncontrolled, paediatrics, claustrophobic patients. Might be general anesthia
- ✓ Less availability
- ✓ High cost

# MRI-Absolute Contraindications

- Cardiac Pacemakers
- Electronic stimulators
- Cardiac valves
- Aneurysm clips
- Metallic foreign bodies

N.B ; Titanium plates are accepted

# Nuclear medicine imaging-5 ( scintigraphy ) (molecular imaging)



# : Scintigraphy (molecular imaging)

1. Planner isotope scanning
2. Single positron emission computed tomography (SPECT)
3. positron emission tomography (PET)
4. Others

- Functional nuclear imaging modality detecting metabolic activity.
- imaging technique used to visualize parts of the body by injecting a small dose of a radioactive chemical into the body, each is absorbed by certain organ and then emit small beams of radiation (gamma rays) that can be detected by the gamma camera
- High negative predictive value (exclude malignancy).
- High percentage of false positive.

## SPECT provides true 3D reformatting.

This information is typically presented as cross-sectional slices through the patient, but can be freely reformatted or manipulated as required.

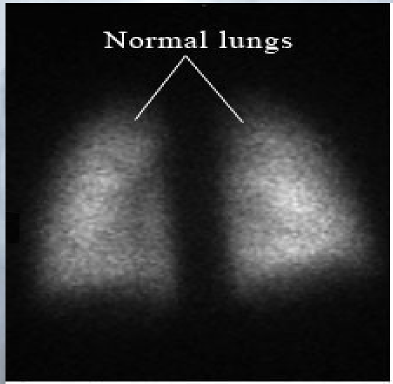


Figure 1

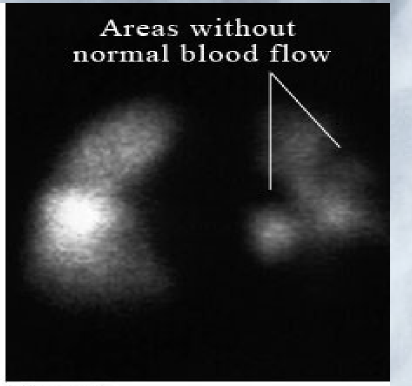
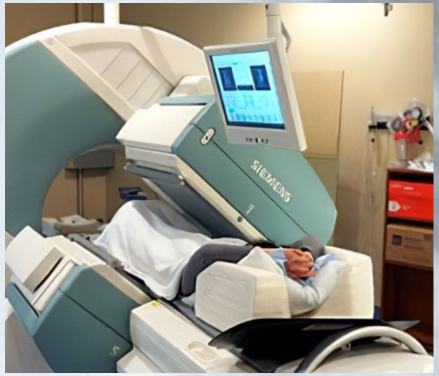
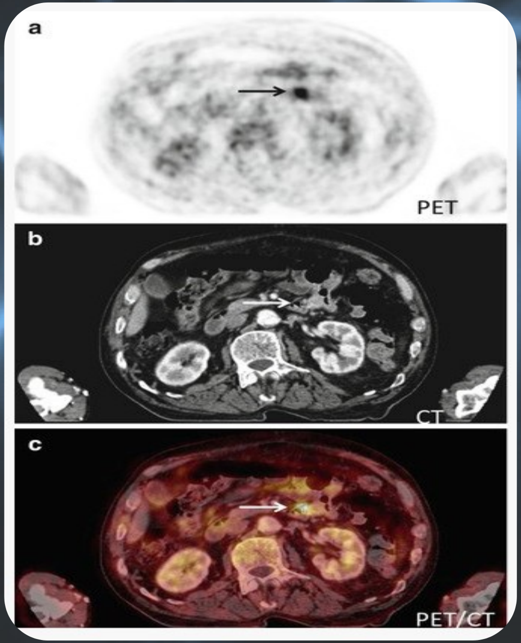
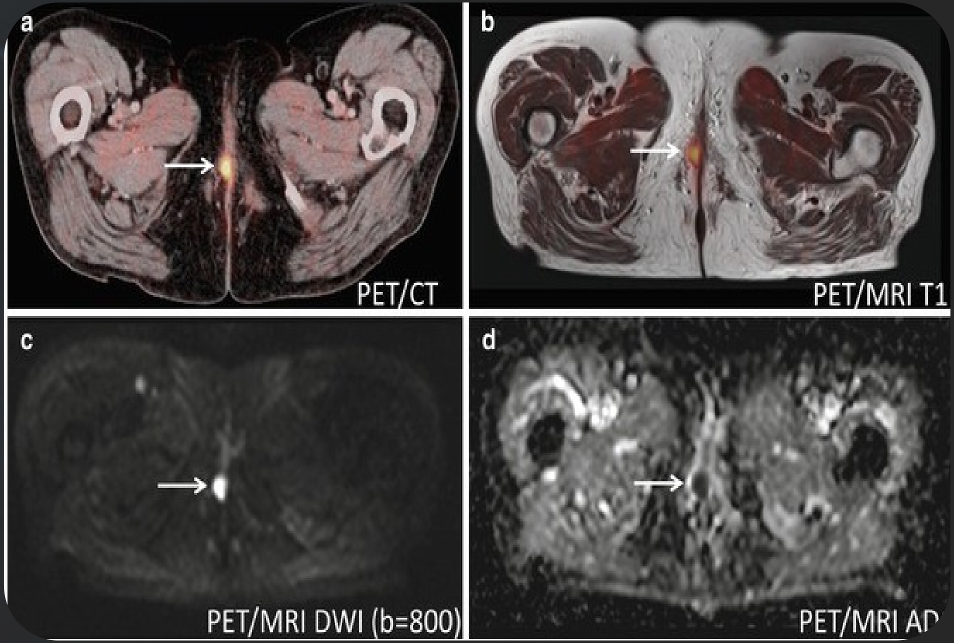


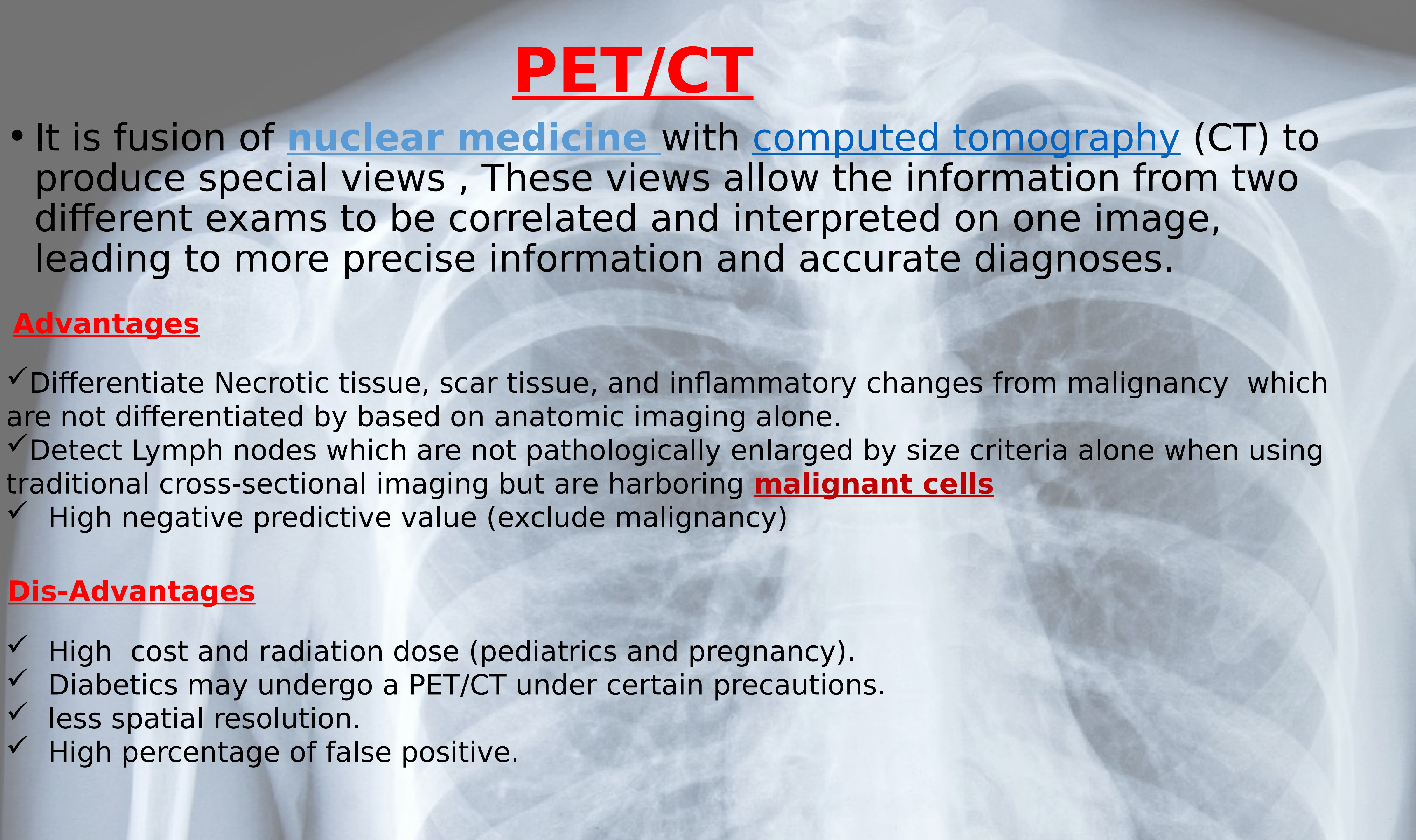
Figure 2



# hYBRID imaging (spect-ct/pet-ct/PET-mri)-6







# PET/CT

- It is fusion of **nuclear medicine** with computed tomography (CT) to produce special views , These views allow the information from two different exams to be correlated and interpreted on one image, leading to more precise information and accurate diagnoses.

## Advantages

✓Differentiate Necrotic tissue, scar tissue, and inflammatory changes from malignancy which are not differentiated by based on anatomic imaging alone.

✓Detect Lymph nodes which are not pathologically enlarged by size criteria alone when using traditional cross-sectional imaging but are harboring **malignant cells**

✓ High negative predictive value (exclude malignancy)

## Dis-Advantages

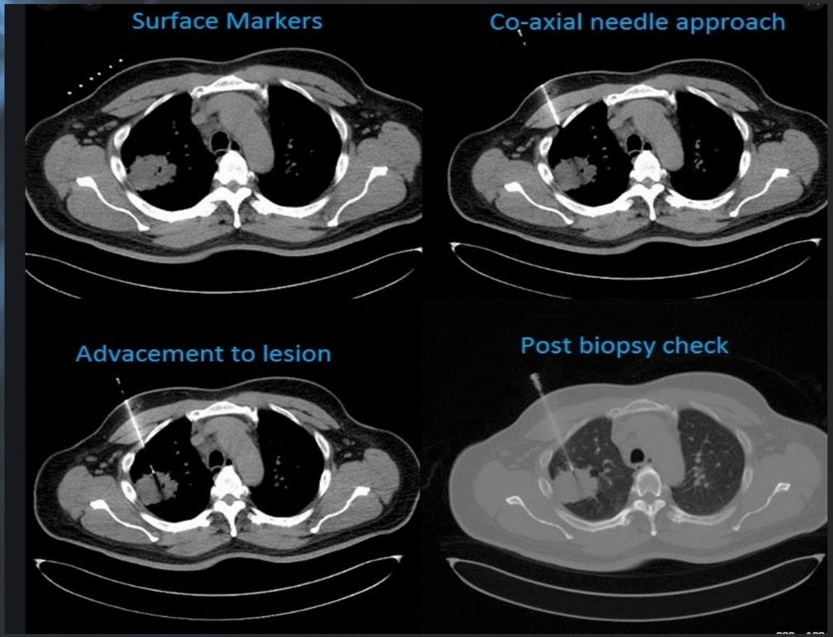
✓ High cost and radiation dose (pediatrics and pregnancy).

✓ Diabetics may undergo a PET/CT under certain precautions.

✓ less spatial resolution.

✓ High percentage of false positive.

# IMAGING- GUDIED-7 Intervention (diagnostic/therapeutic)



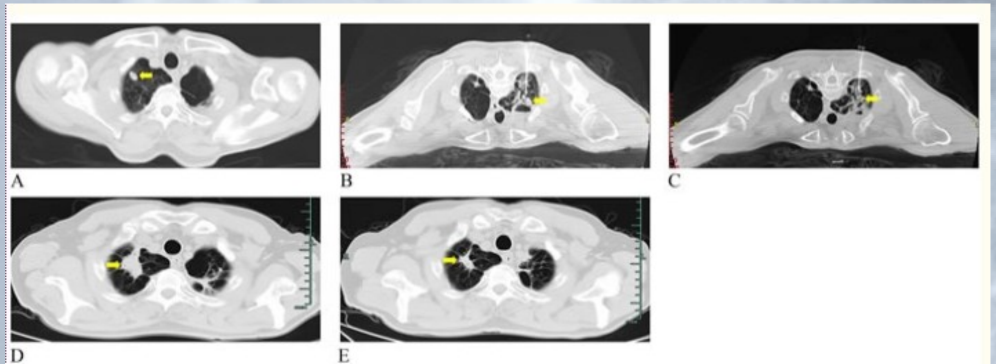
## CT Guided Biopsy

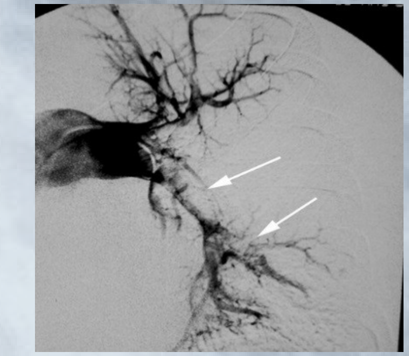
- Minimally invasive procedure and is an alternative to an open surgical biopsy. CT guidance generally results in fewer complications, a faster recovery time, and avoidance of general anesthesia.
- Difficult in small lesions and risky in central and prevascular lesions.
- Complication such as pulmonary haemorrhage and pneumothorax are frequent, but usually easy to manage

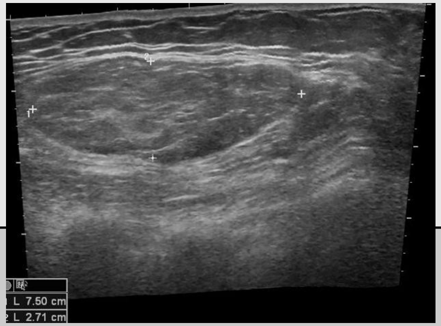
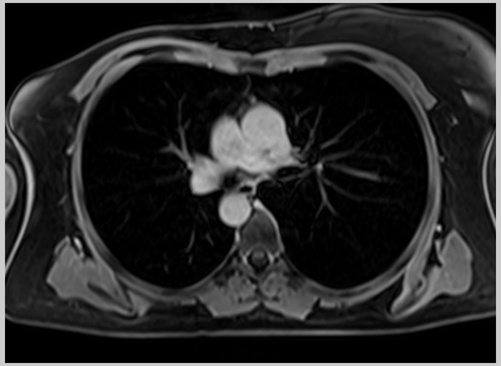
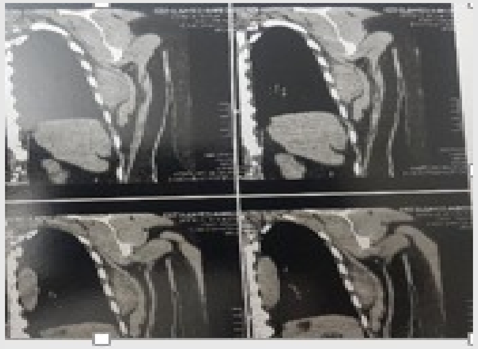
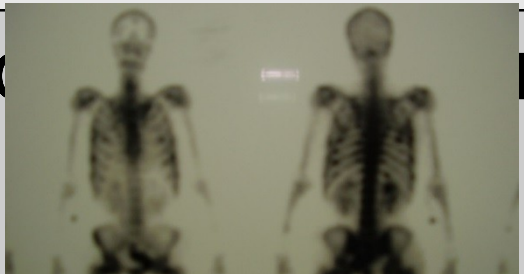
**Pleural effusion image guided aspiration:** diagnostic or therapeutic

**Laser ablation of lung carcinoma**

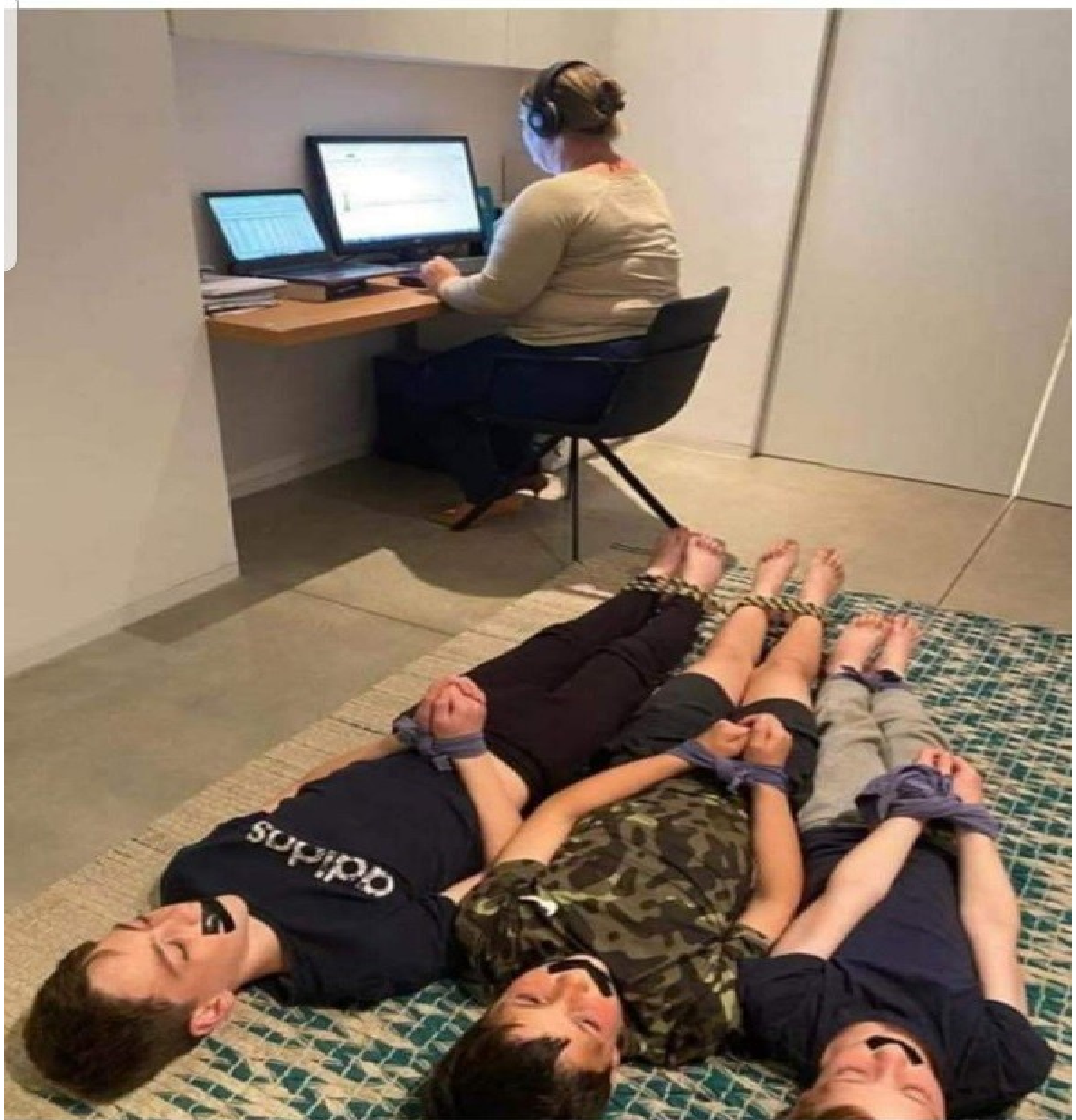
**Pulmonary artery intervention:** diagnostic or therapeutic





| | | |
|---|---|---|
| | Superficial lesions | US  |
| | Deep chest wall, mediastinal lesion and bone marrow lesions | MRI  |
| | Pulmonary, vascular and Bony wall lesions | CT  |
| | Bone marrow and metabolically active soft tissue | Nuc ne  |

Working from home….



# ii. Clinical Imaging Guidelines (CIG)

# Vitality of Imaging Referral guidelines Implementation projects

- Such projects have become so vital for the use of radiology departments and improving the quality of health care that they were introduced in the Medical Exposure Directive  of 1997 as a legally-binding requirement for EU Member States.
- Subsequently, the European Commission launched a project to develop European referral guidelines, which were first published in the UK to help Member States with the adoption of national guidelines as their legal responsibility.
- One of the most important conditions for the work of health insurance hospitals in European countries is to ensure their application of the principles of Clinical referral  guidelines.

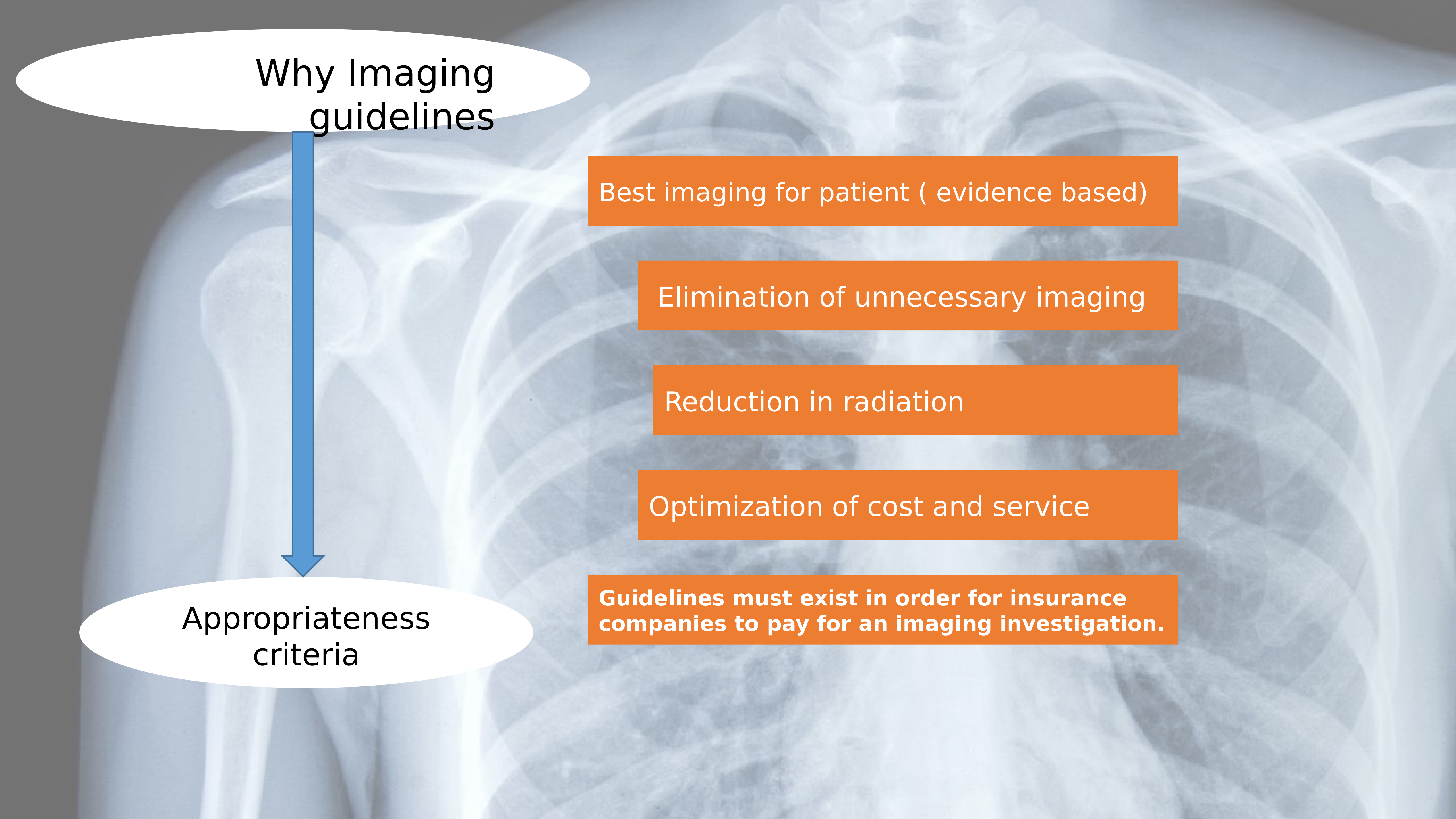
# Justification

- Process in which the referring health care provider and radiologist make a decision as to whether the examination is clinically indicated and whether the benefits outweigh the likely radiation risks
- There are estimates that a significant fraction of examinations are unjustified
- When available, alternative techniques such as ultrasound and MRI will be used
- Pay attention to previous procedures and the information availabl n the referring practitioner, the patient and their family

# Optimisation

- **ALARA** principle states that dose should be kept **As Low As Reasonable Achievable**
- But not to the extent that compromises diagnostic image quality
- As the dose and risk increases benefits should be greater

# Why Imaging guidelines



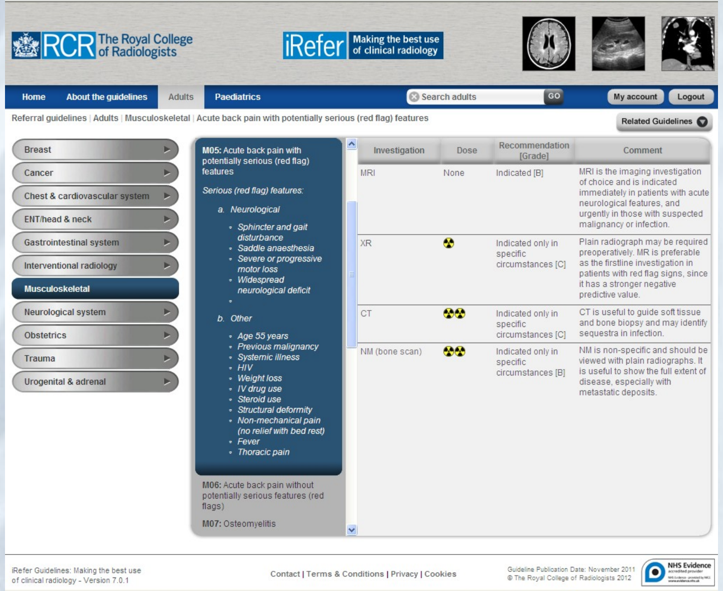
Appropriateness criteria

- Best imaging for patient ( evidence based)
- Elimination of unnecessary imaging
- Reduction in radiation
- Optimization of cost and service
- **Guidelines must exist in order for insurance companies to pay for an imaging investigation.**

# : The guidelines are available as

Making the Best Use of a Department of Clinical Radiology
Making the best use of clinical radiology services
iRefer
RCR

Booklet



Referral guidelines | Adults | Musculoskeletal | Acute back pain with potentially serious (red flag) features

**M05:** Acute back pain with potentially serious (red flag) features

*Serious (red flag) features:*

a. *Neurological*
   - *Sphincter and gait disturbance*
   - *Saddle anaesthesia*
   - *Severe or progressive motor loss*
   - *Widespread neurological deficit*

b. *Other*
   - *Age 55 years*
   - *Previous malignancy*
   - *Systemic illness*
   - *HIV*
   - *Weight loss*
   - *IV drug use*
   - *Steroid use*
   - *Structural deformity*
   - *Non-mechanical pain (no relief with bed rest)*
   - *Fever*
   - *Thoracic pain*

**M06:** Acute back pain without potentially serious features (red flags)

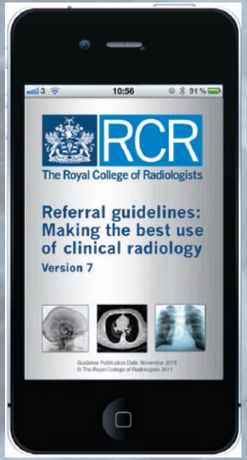
**M07:** Osteomyelitis

| Investigation | Dose | Recommendation [Grade] | Comment |
|---|---|---|---|
| MRI | None | Indicated [B] | MRI is the imaging investigation of choice and is indicated immediately in patients with acute neurological features, and urgently in those with suspected malignancy or infection. |
| XR | ☢ | Indicated only in specific circumstances [C] | Plain radiograph may be required preoperatively. MR is preferable as the firstline investigation in patients with red flag signs, since it has a stronger negative predictive value. |
| CT | ☢☢ | Indicated only in specific circumstances [C] | CT is useful to guide soft tissue and bone biopsy and may identify sequestra in infection. |
| NM (bone scan) | ☢☢ | Indicated only in specific circumstances [B] | NM is non-specific and should be viewed with plain radiographs. It is useful to show the full extent of disease, especially with metastatic deposits. |

iRefer Guidelines: Making the best use of clinical radiology - Version 7.0.1

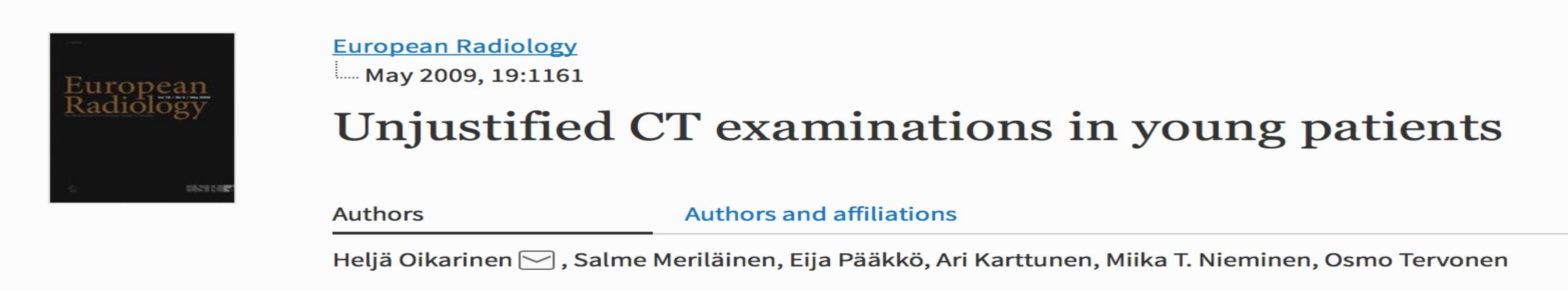
Guideline Publication Date: November 2011
© The Royal College of Radiologists 2012

online version



Referral guidelines: Making the best use of clinical radiology
Version 7

app (available for Android or iOS)



European Radiology

May 2009, 19:1161

**Unjustified CT examinations in young patients**

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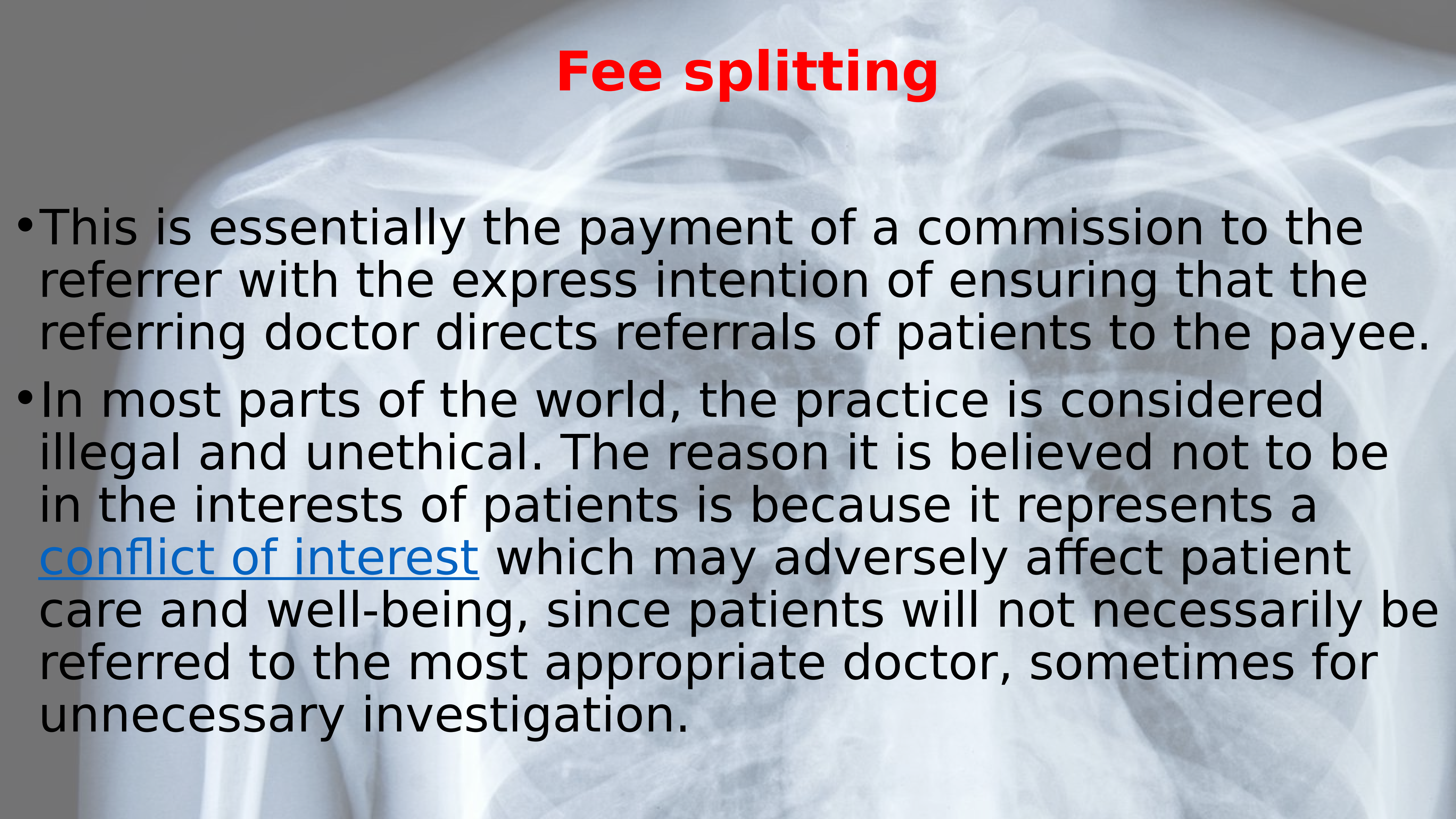
of all CT examinations were NOT justified 30%

- CT Lumbar spine - 77%
- CT head - 36%
- CT abdomen - 37%

## Challenges against implementation of CIG

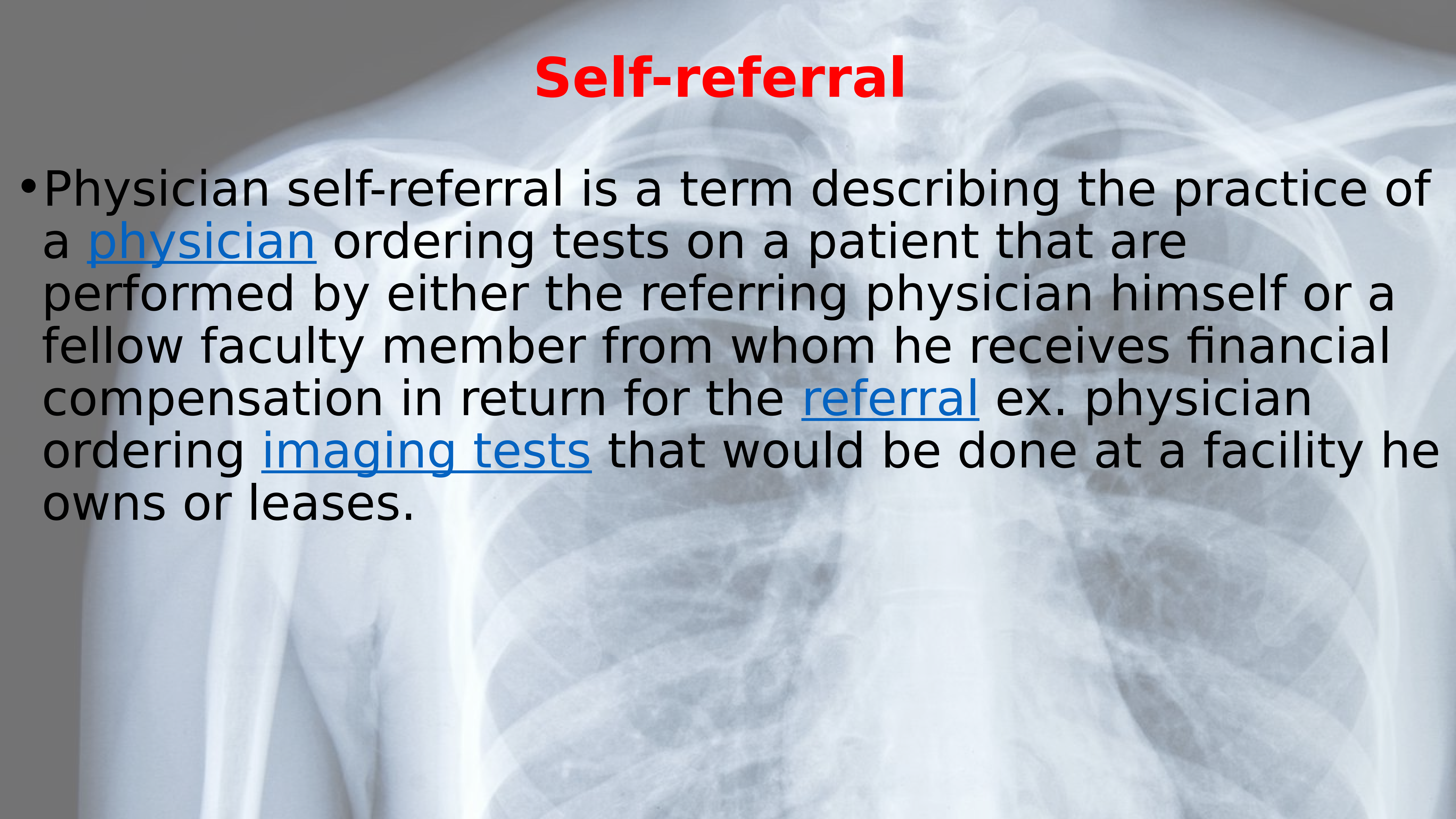
- Unawareness of physicians and radiologists by clinical imaging guidelines
- Congestion in clinics
- Patients pressure to perform the investigation
- Uneven Distribution of machines
- Fee splitting
- Self referral

# Fee splitting



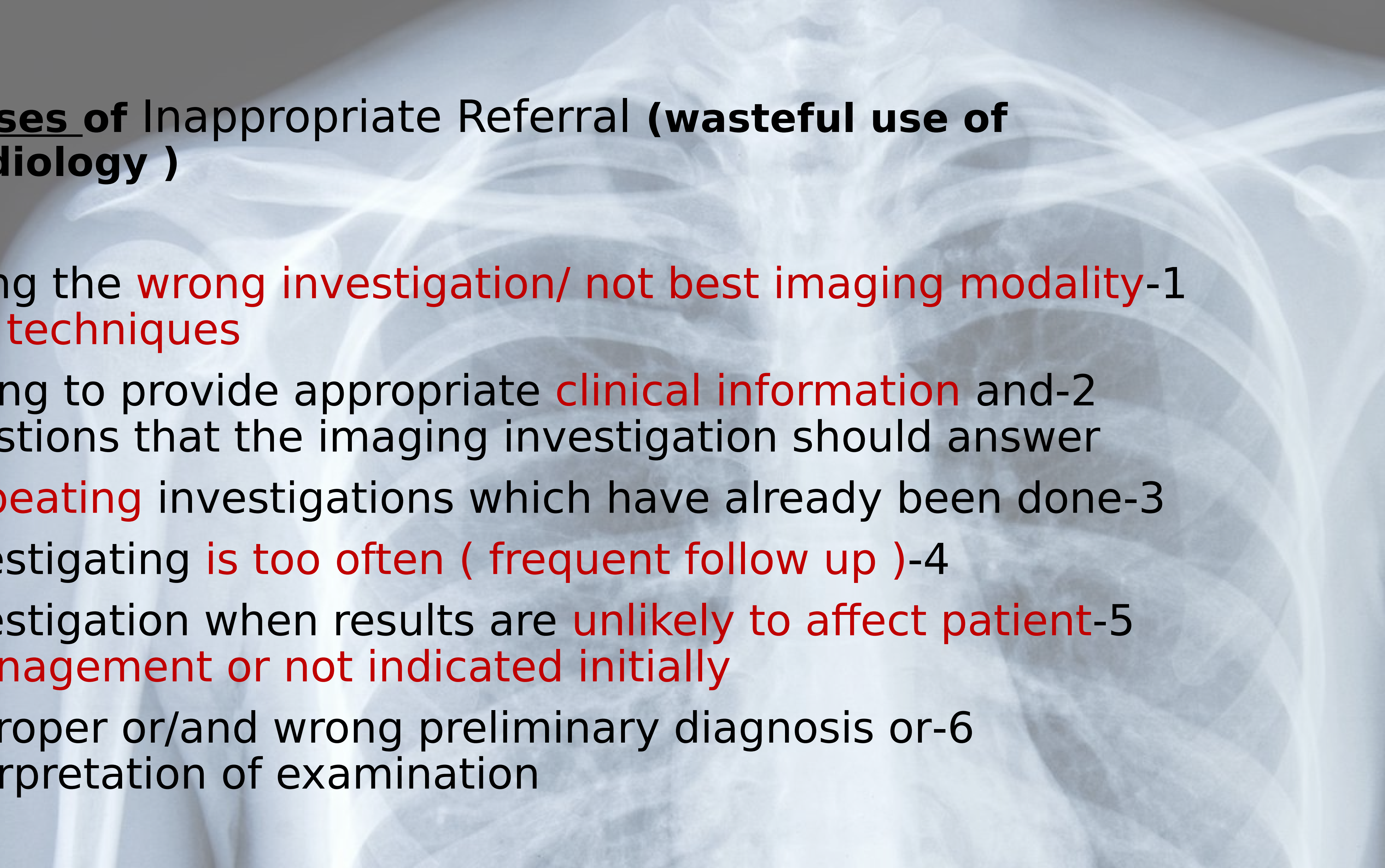
- This is essentially the payment of a commission to the referrer with the express intention of ensuring that the referring doctor directs referrals of patients to the payee.
- In most parts of the world, the practice is considered illegal and unethical. The reason it is believed not to be in the interests of patients is because it represents a conflict of interest which may adversely affect patient care and well-being, since patients will not necessarily be referred to the most appropriate doctor, sometimes for unnecessary investigation.

# Self-referral



- Physician self-referral is a term describing the practice of a physician ordering tests on a patient that are performed by either the referring physician himself or a fellow faculty member from whom he receives financial compensation in return for the referral ex. physician ordering imaging tests that would be done at a facility he owns or leases.

# iii. Inappropriate Referral



## **Causes of** Inappropriate Referral **(wasteful use of** : **radiology )**

Doing the wrong investigation/ not best imaging modality-1
.+/- techniques

Failing to provide appropriate clinical information and-2
questions that the imaging investigation should answer

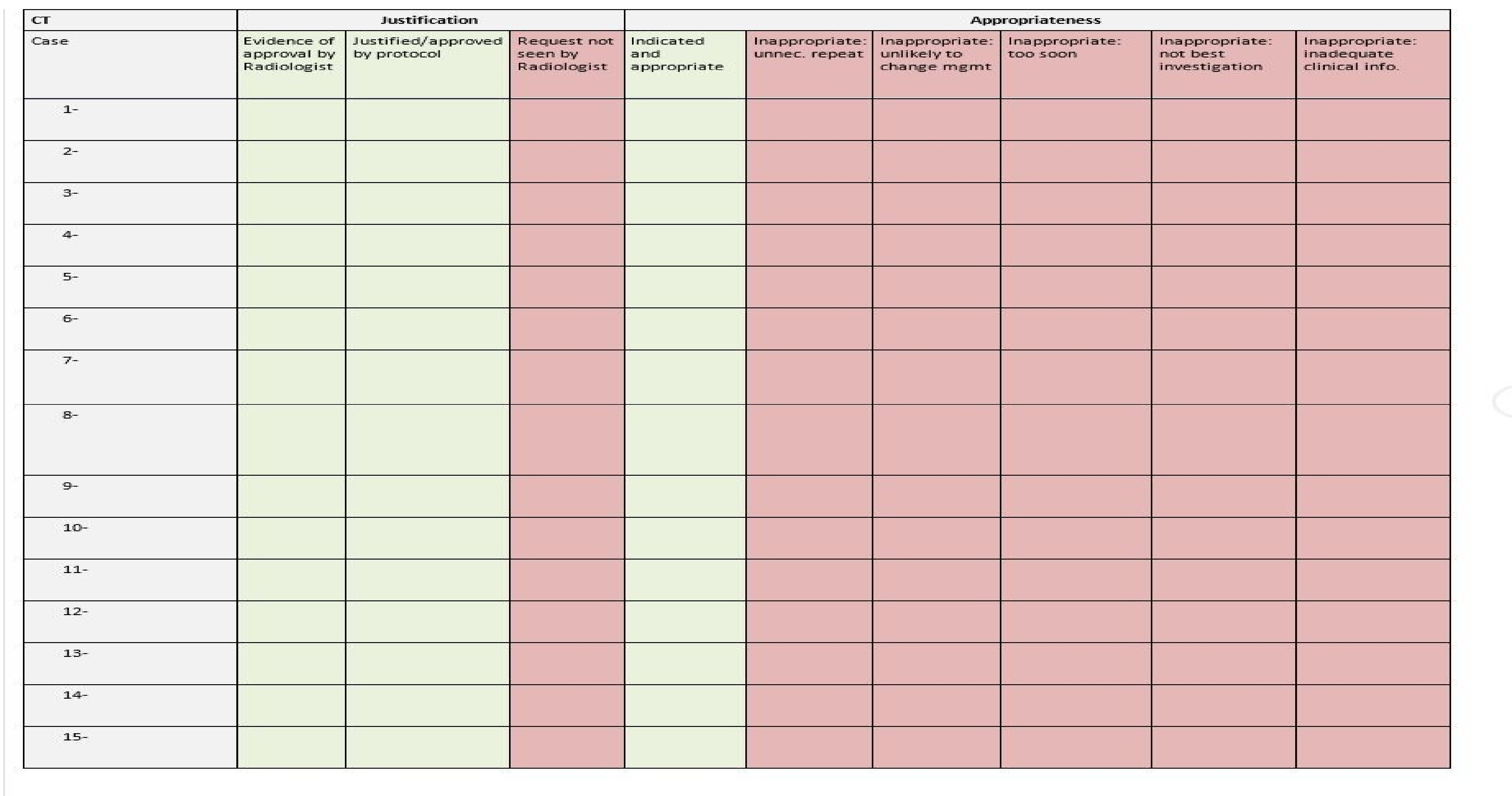
.Repeating investigations which have already been done-3

Investigating is too often ( frequent follow up )-4

Investigation when results are unlikely to affect patient-5
.management or not indicated initially

improper or/and wrong preliminary diagnosis or-6
interpretation of examination

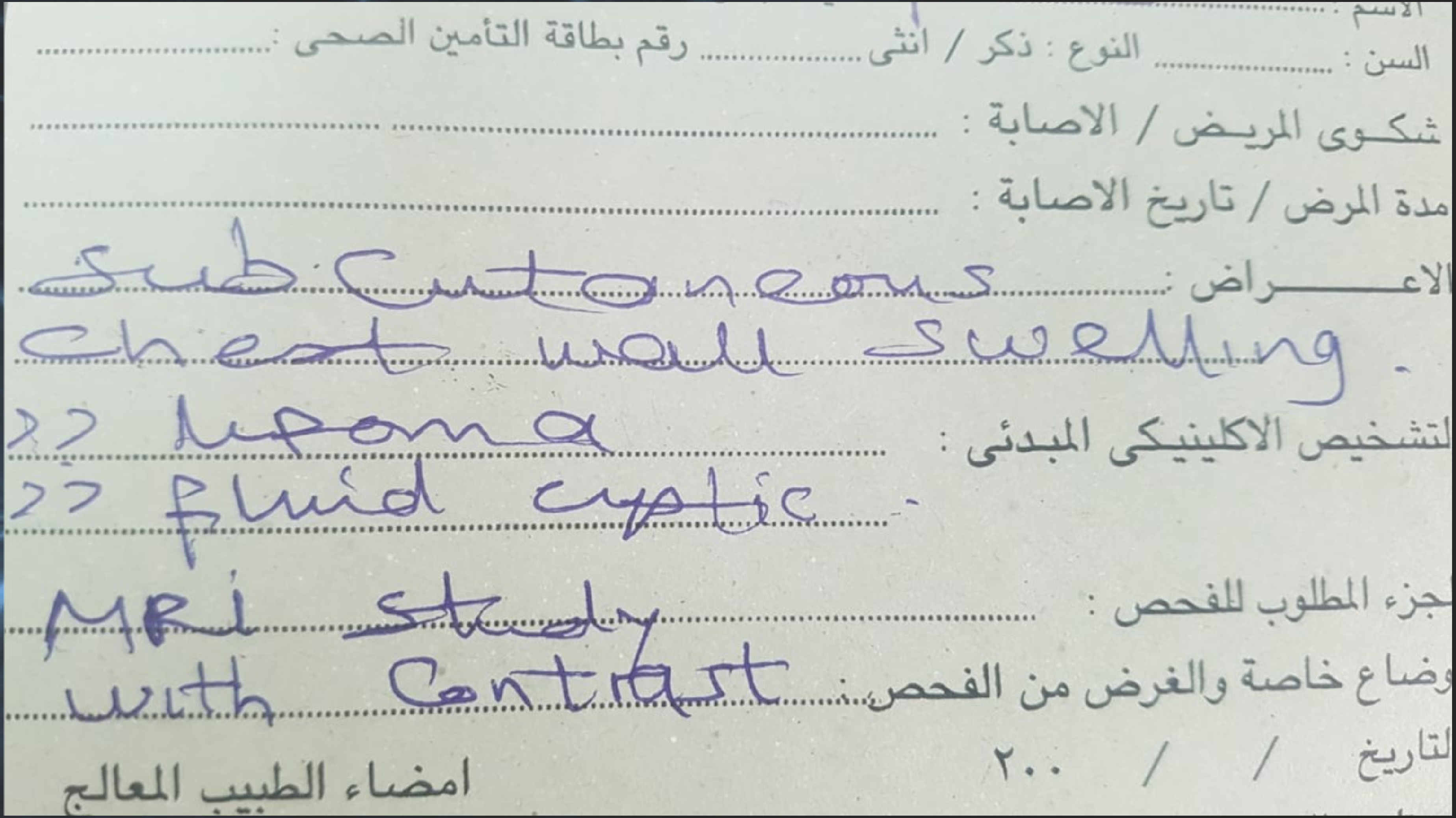
Guidelines did not equate with their use. As Guidelines cannot encompass all clinical scenarios, adherence can only be expected in up to 90 % of clinical scenarios (Audit of appropriate imaging).



| CT | Justification | | | Appropriateness | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Case | Evidence of approval by Radiologist | Justified/approved by protocol | Request not seen by Radiologist | Indicated and appropriate | Inappropriate: unnec. repeat | Inappropriate: unlikely to change mgmt | Inappropriate: too soon | Inappropriate: not best investigation | Inappropriate: inadequate clinical info. |
| 1- | | | | | | | | | |
| 2- | | | | | | | | | |
| 3- | | | | | | | | | |
| 4- | | | | | | | | | |
| 5- | | | | | | | | | |
| 6- | | | | | | | | | |
| 7- | | | | | | | | | |
| 8- | | | | | | | | | |
| 9- | | | | | | | | | |
| 10- | | | | | | | | | |
| 11- | | | | | | | | | |
| 12- | | | | | | | | | |
| 13- | | | | | | | | | |
| 14- | | | | | | | | | |
| 15- | | | | | | | | | |

**Not the best imaging modality**

**Ultrasound is the best to characterized subcutaneous lesions**



الاسم : ..........................

السن : ..................... النوع : ذكر / انثى .................. رقم بطاقة التأمين الصحى : ..........................

شكـوى المريـض / الاصابة : ..........................

مدة المرض / تاريخ الاصابة : ..........................

الاعـــــــراض : Subcutaneous chest wall swelling.

لتشخيص الاكلينيكى المبدئى : >> lipoma >> fluid cystic -

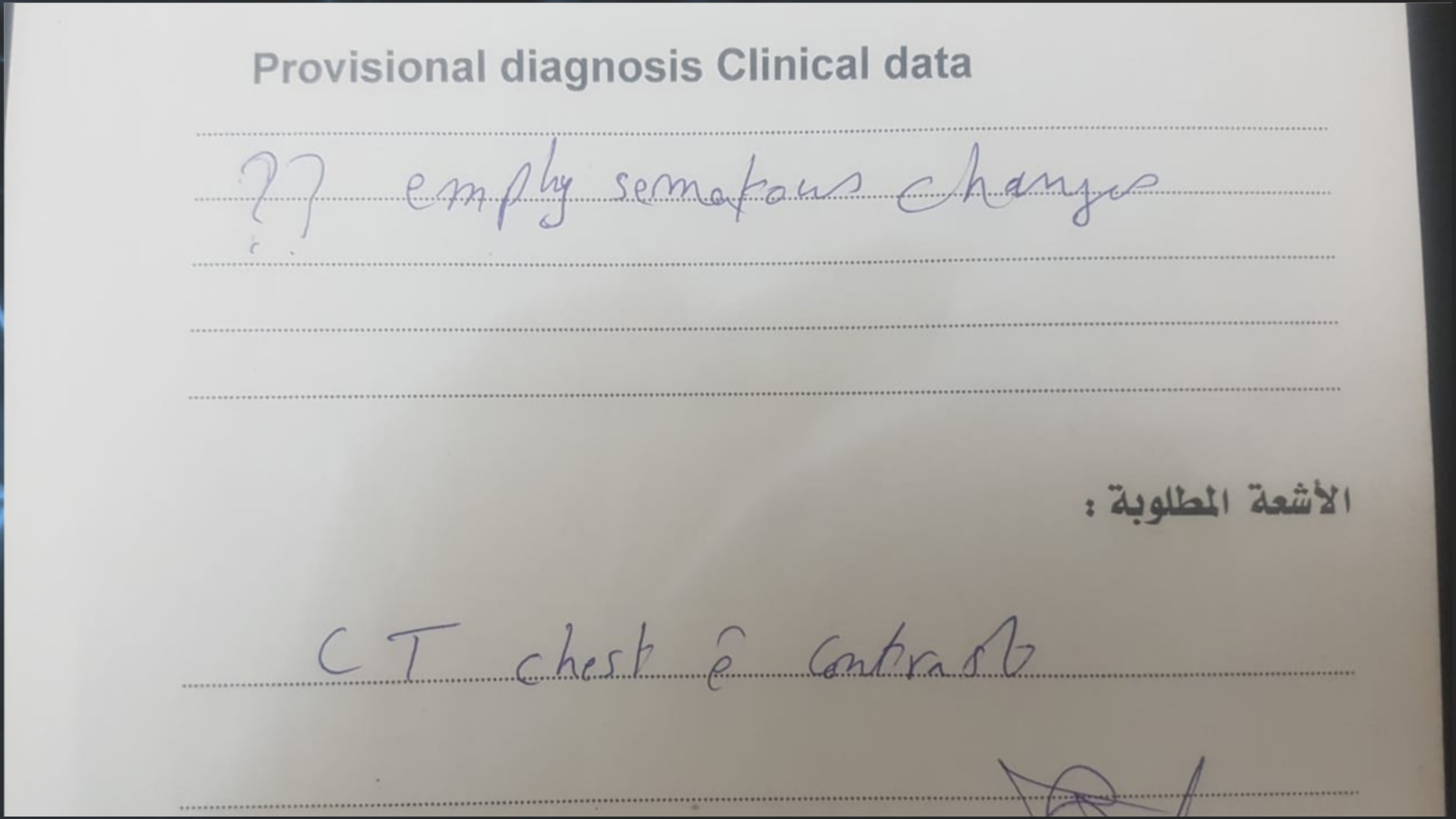
جزء المطلوب للفحص : MRI study

وضاع خاصة والغرض من الفحص : with Contrast

لتاريخ / / ٢٠٠

امضاء الطبيب المعالج

# Not the best imaging technique
# Non contrast CT is optimum



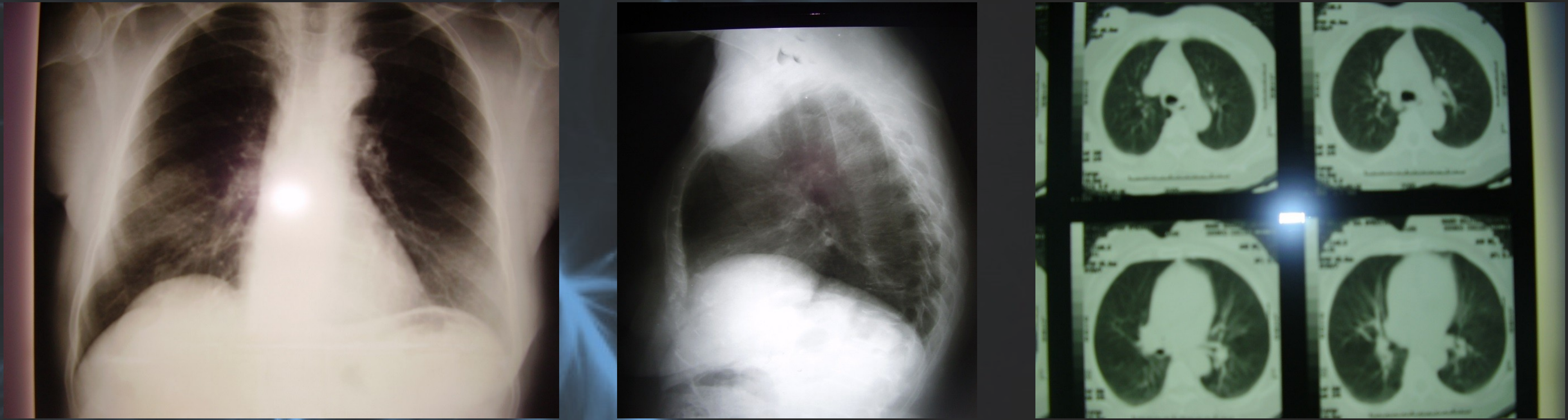
**Provisional diagnosis Clinical data**

?? emphy sematous changes

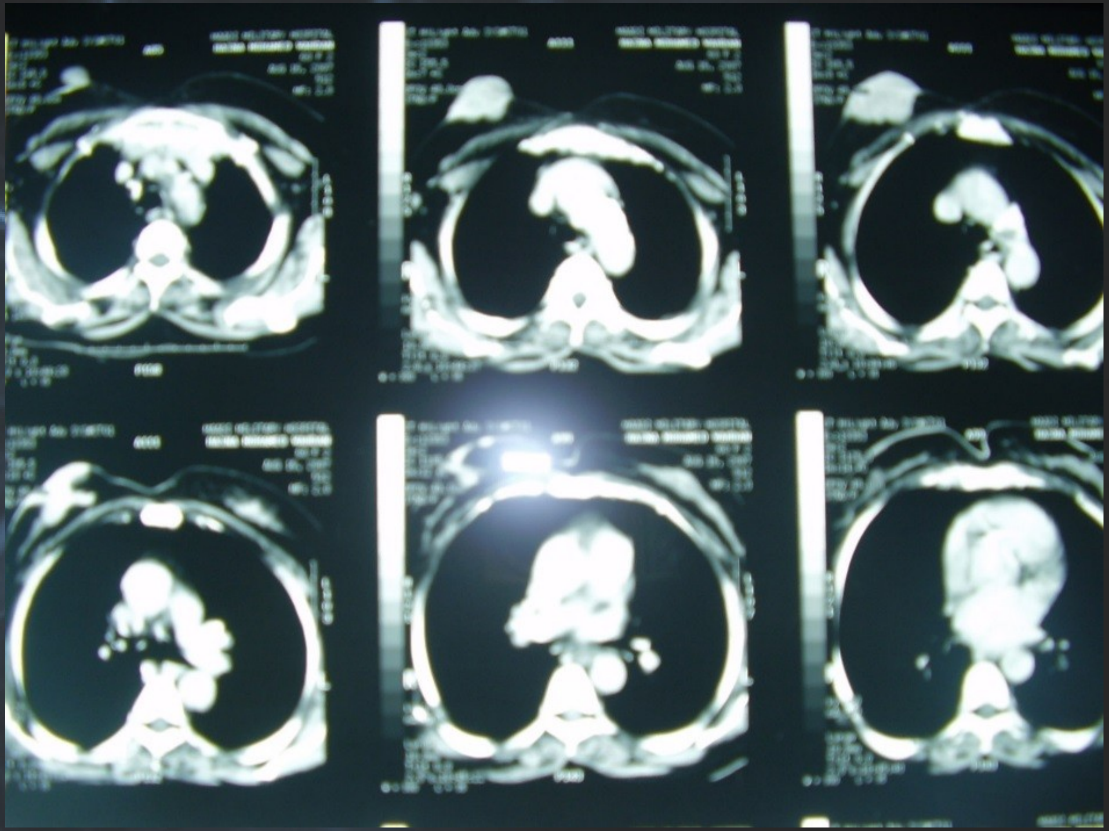
**الأشعة المطلوبة :**

CT chest ē contrast

# 2-Inadequate clinical data

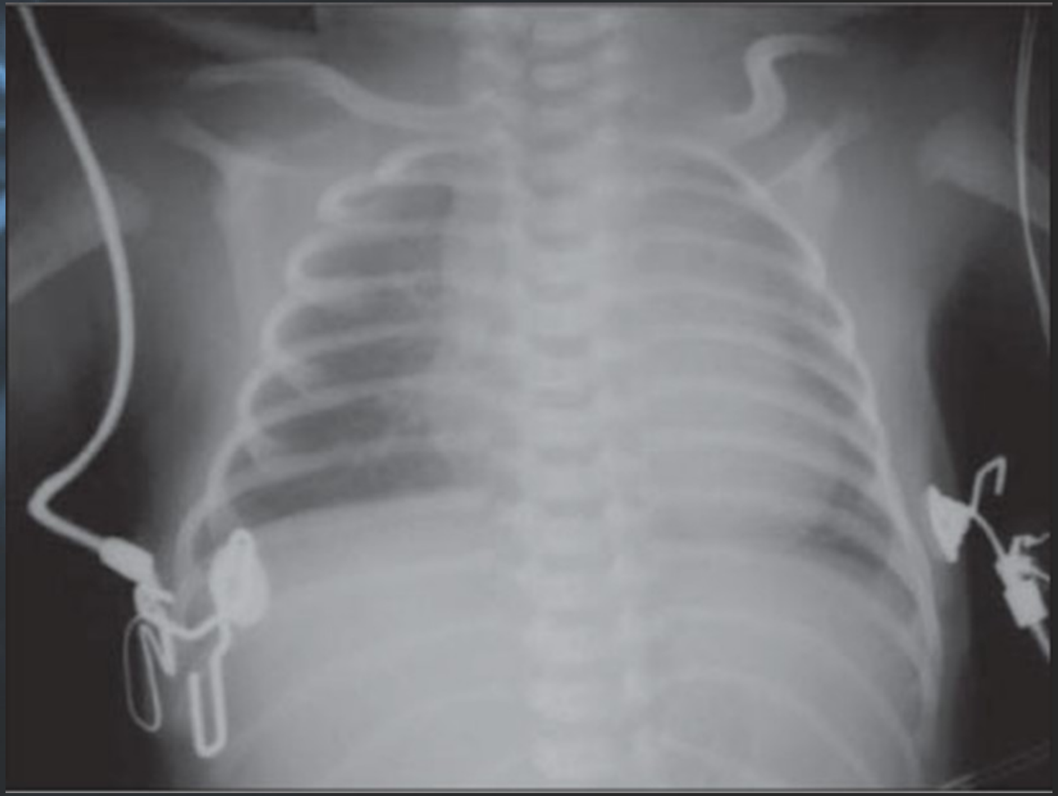


# 2-Inadequate clinical data

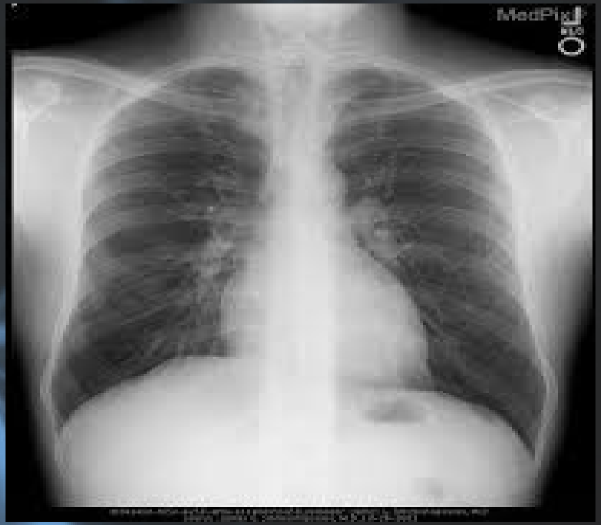


# Investigating is too often ( frequent follow up )-4

Abuse request of chest X-Ray e.g. in the neonatal ICU, with a portable x-ray equipment(high radiation sensitivity in paediatric age group)

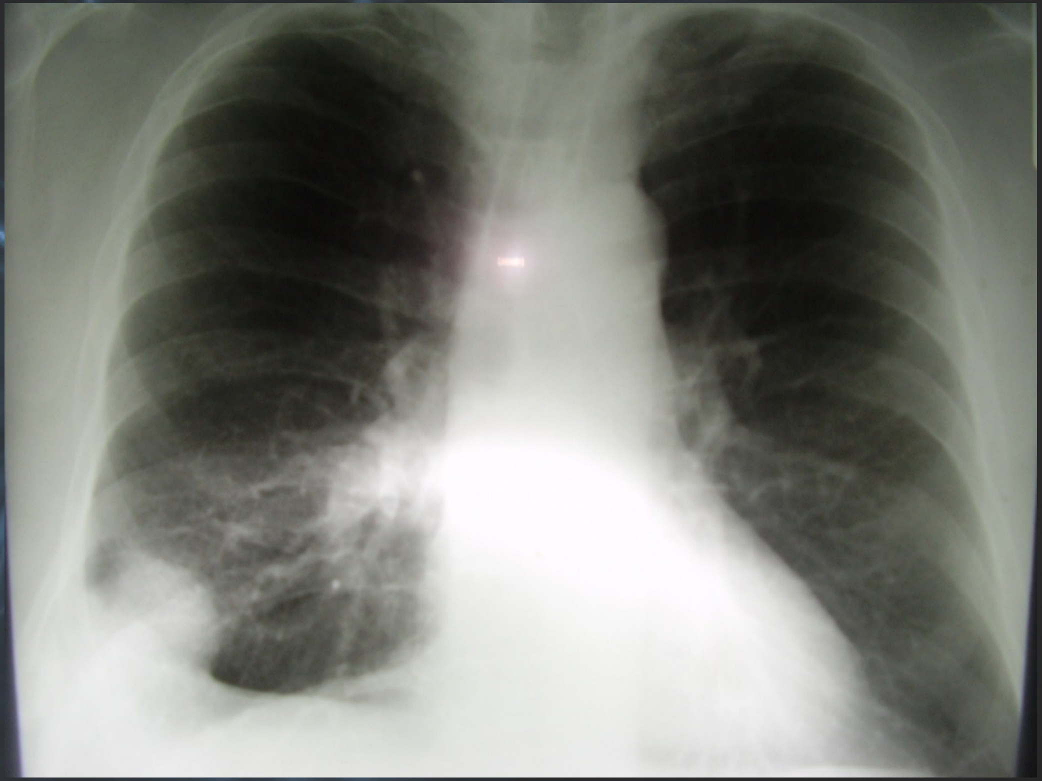


# Investigation when results are unlikely to affect patient management-5 .or not indicated initially

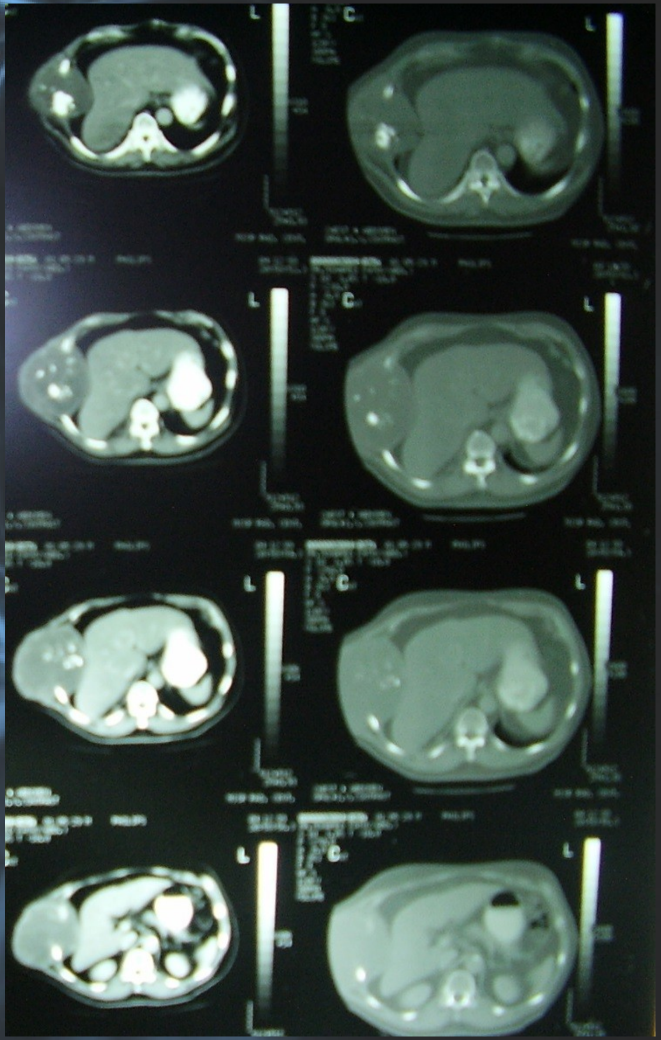


Bronchial asthma (no abnormalities )

# improper or/and wrong preliminary diagnosis or **-6** interpretation of examination

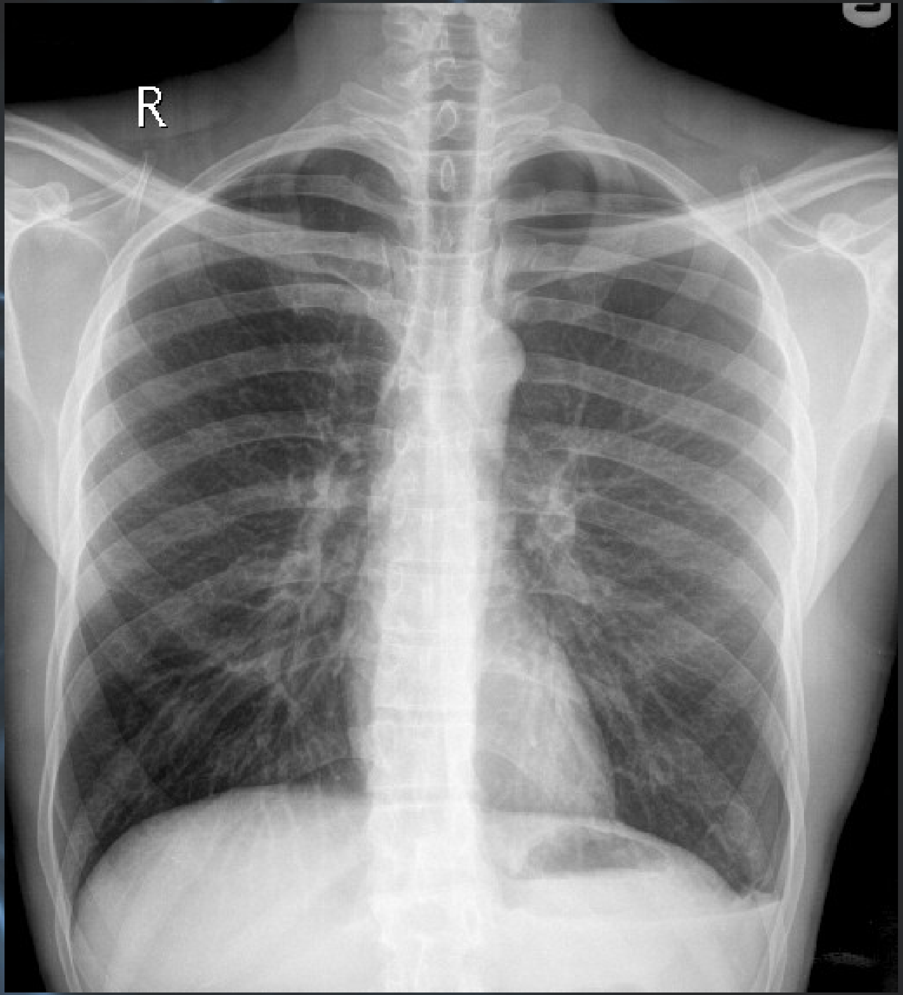


Improper interpretation as pneumonia > not ask immediately for another imaging modality



- Destructive bony lesion and soft tissue component
- Diagnosis: chondrosarcoma

# improper or/and wrong preliminary diagnosis or **-6** interpretation of examination

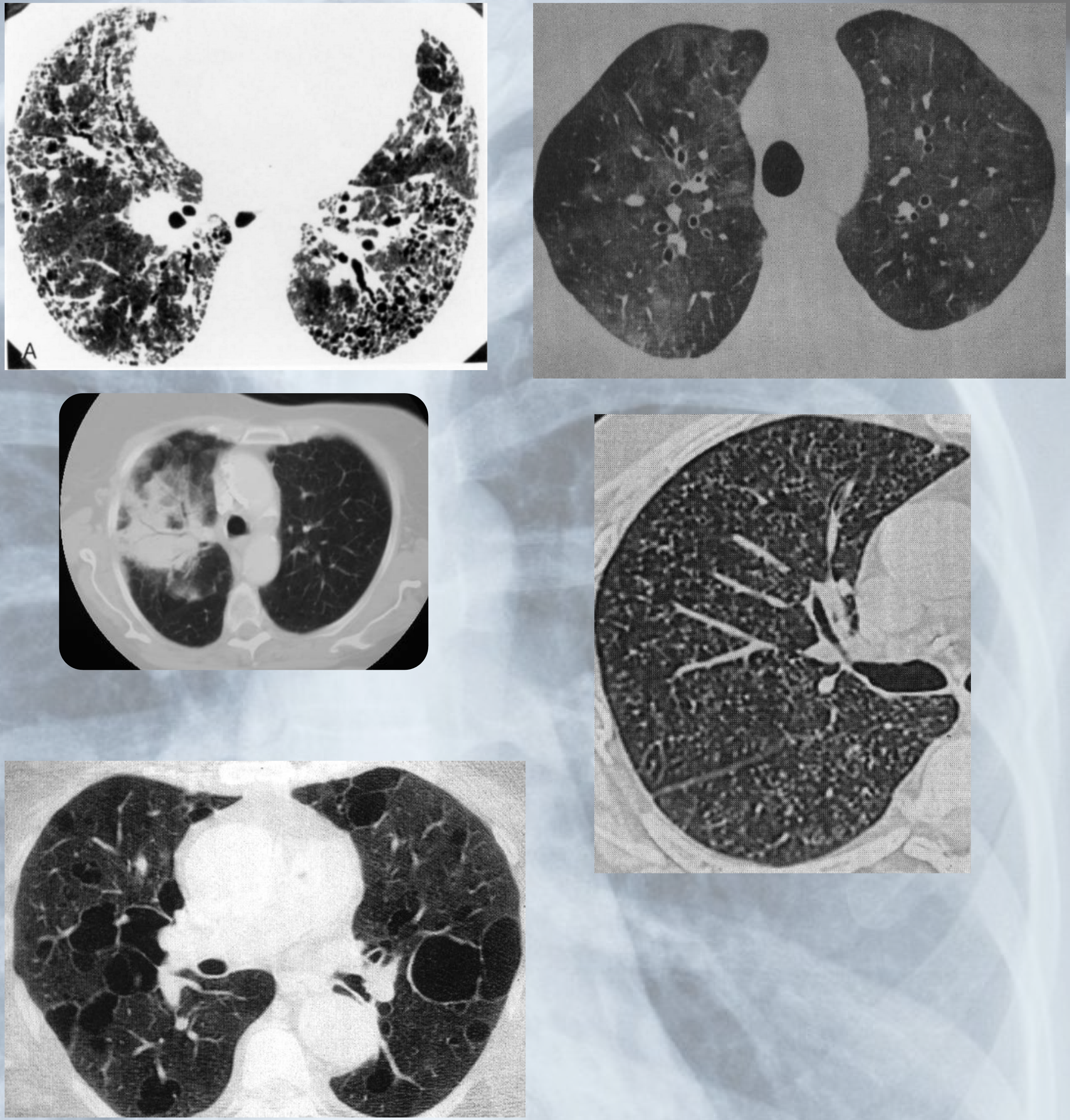


What are the radiological findings

# **Don’t hesitate to discuss the best imaging modality with radiologist**

# iv. Common patterns

# Radiological Patterns Of 5 Lung Diseases



Reticular pattern-1

Ground glass pattern (veiling)-2

Consolidation pattern-3

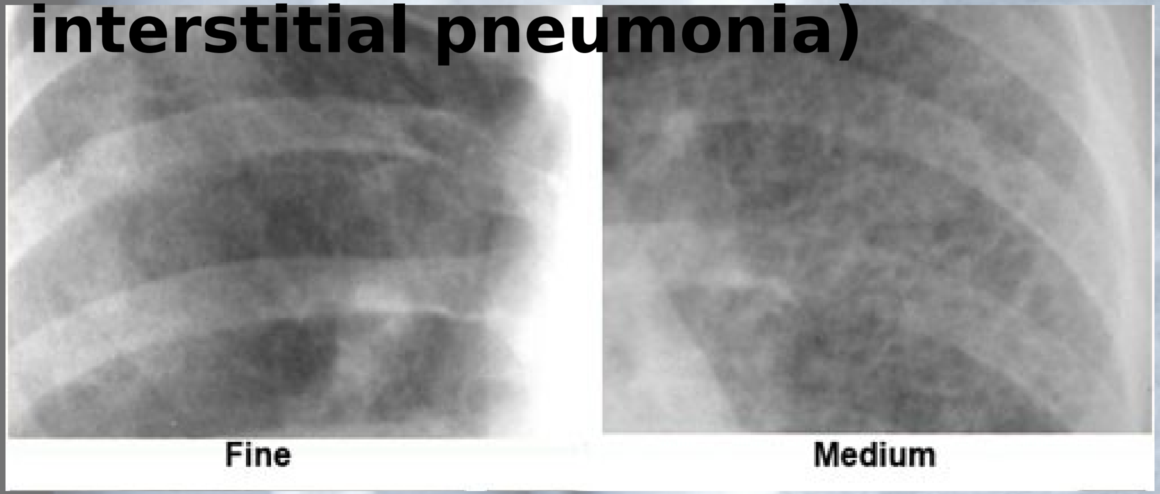
Nodular pattern-4

Cystic pattern-5

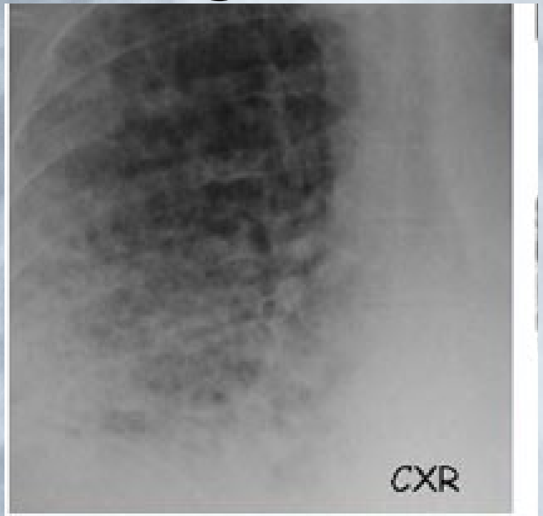
Could be combined namely reticular-honeycombing, veiling - consolidation

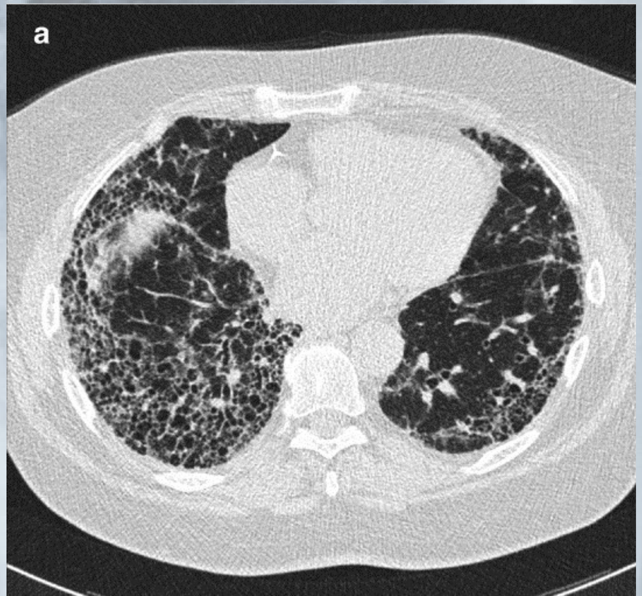
# Reticular -1 pattern

- The reticular appearance refers to a collection of innumerable small linear opacities that together produce an appearance resembling a “net” The pattern can be fine, medium or coarse.
- Fine and medium patterns are shown here. Reticular patterns represent interstitial lung disease.
- May be accompanied by honey-combing (usual interstitial pneumonia)


Fine

Medium





# Septal Thickening

- An interlobular septum marginates part of a secondary pulmonary lobule and contains pulmonary veins and lymphatics. These septa measure approximately 0.1 mm in thickness and are occasionally seen on normal thin-section CT scans. Abnormal thickening of interlobular septa is caused by fibrosis, edema, or infiltration by cells or other material. Within the peripheral lung, thickened septa 1 to 2 cm in length may outline part or all of a secondary pulmonary lobule, perpendicular to the pleural surface. They represent the CT counterpart of Kerley B lines seen on chest radiographs.

# Tree-in-Bud Pattern

- Centrilobular bronchial dilatation and filling by mucus, pus, or fluid, associated with a linear branching pattern that resembles a budding tree and is generally more pronounced in the lung periphery
- Although first described in cases of endobronchial spread of tuberculosis and considered pathognomonic of this condition, this pattern is now recognized as a CT manifestation of various other noninfectious entities

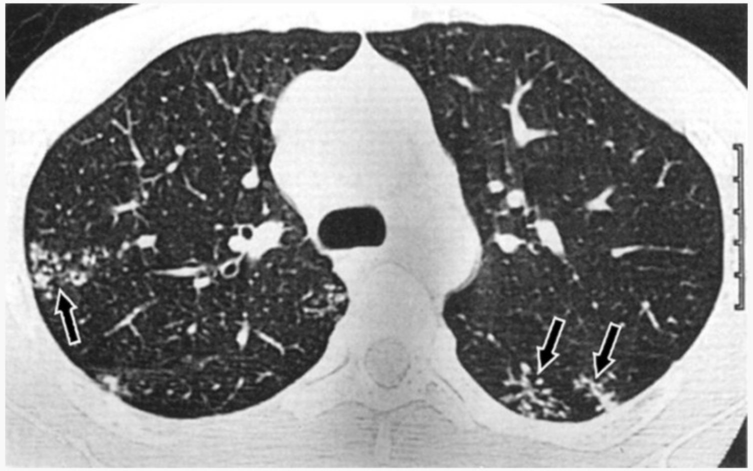


Fig. 3.5

**Tree-in-bud pattern**. Centrilobular bronchial dilatation and filling by mucus associated with a linear branching pattern (arrows) [1]

# Mosaic Attenuation Pattern

- Heterogeneous CT lung attenuation with well-defined borders, corresponding to the secondary pulmonary lobules
- The name derives from mosaic artwork, wh of variously colored glass or stone inlaid in pattern

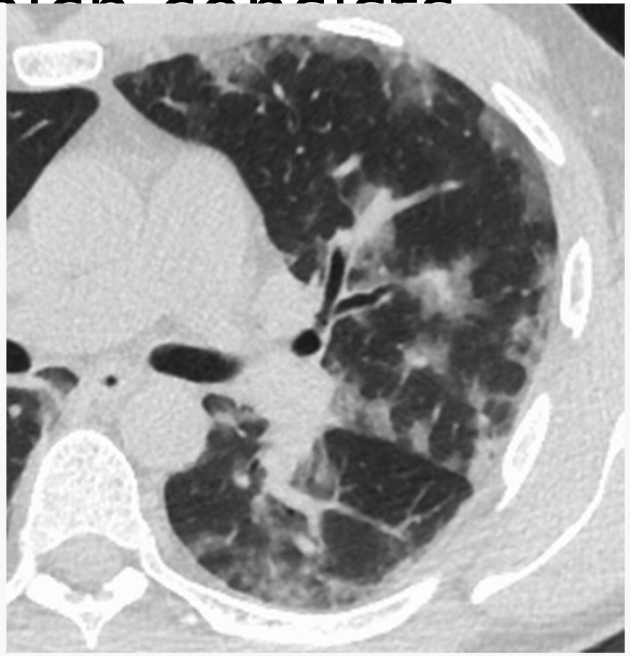


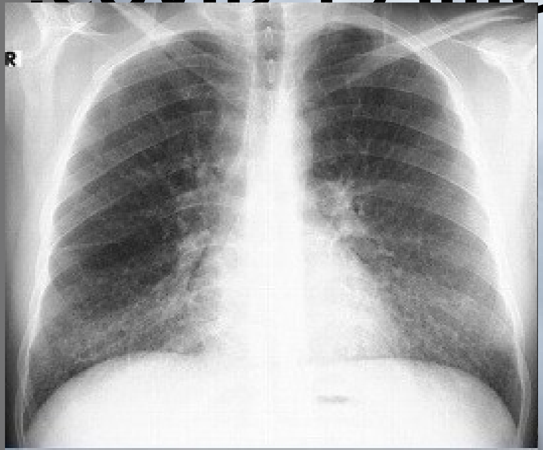
Fig. 3.6

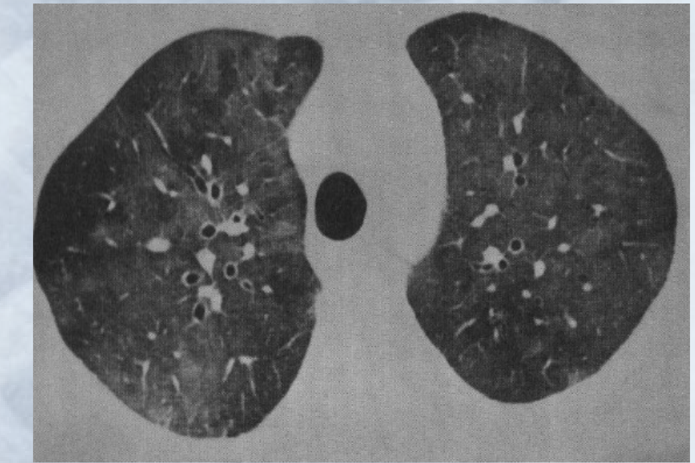
**Mosaic attenuation**. Ground-glass opacification that spares single and multilobular regions in a patient with chemical bronchiolitis following a witnessed episode of aspiration [4]

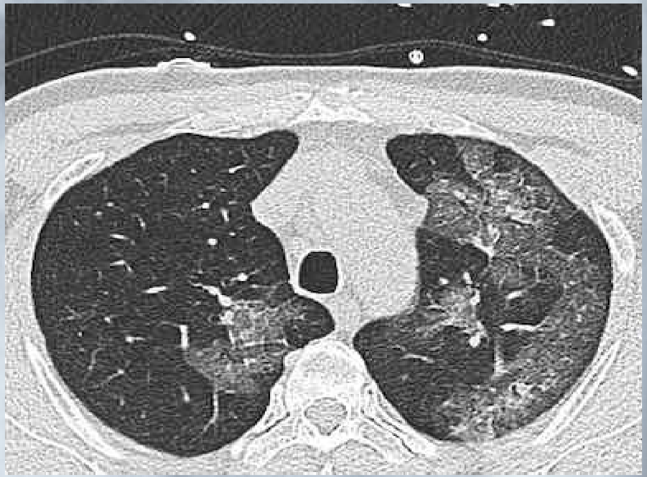
# ound glass pattern(GGO)-2 veiling

**Ground-glass opacification/opacity (GGO) is partial alveolar filling which is referring to an area of increased attenuation in the lung on computed tomography with visualization bronchial and vascular markings. It is a non-specific sign with a wide etiology including infection, chronic interstitial disease and cardiogenic-oedema (central gravitational)**

**Ground glass (GGO) pattern is the most common finding in .COVID-19 infections**

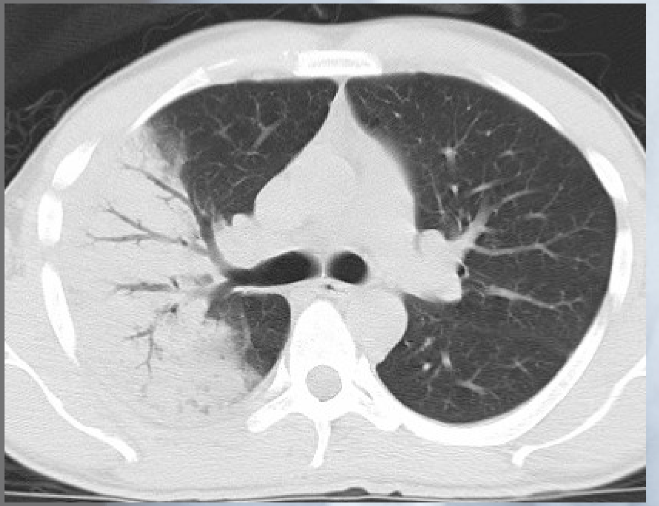






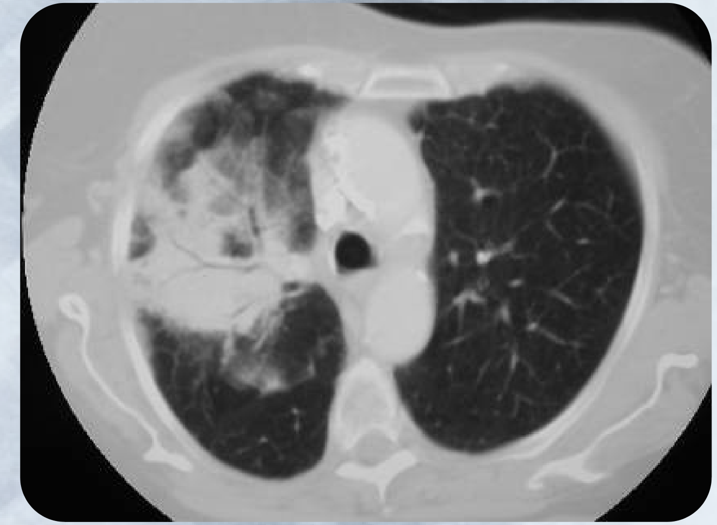
# nsolidation pattern-3

**Consolidation is an complete alveolar-filling process that replaces air within the affected airspaces, increasing in pulmonary attenuation and obscuring the margins of adjacent airways and .vessels on radiographs and CT scans**

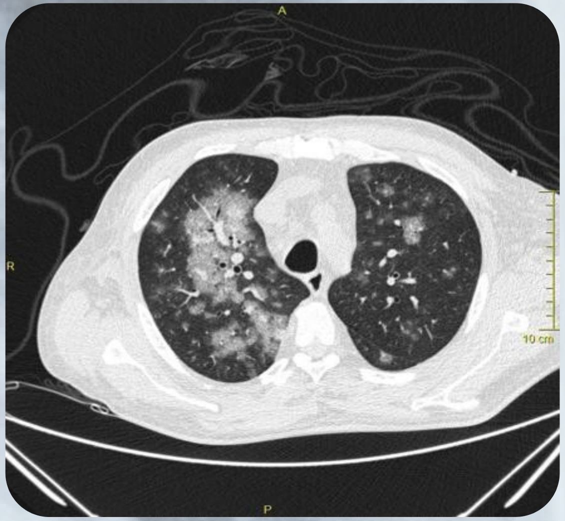


**Pneumonia**

Air Broncho-grams



**Lung cancer**



**HEMORRHAGE**

# Nodular-4 pattern

**Nodular opacification is one of the broad patterns of pulmonary opacification that can be described on .a Chest radiography or Chest CT**

**Nodular opacification in the lung may be a**

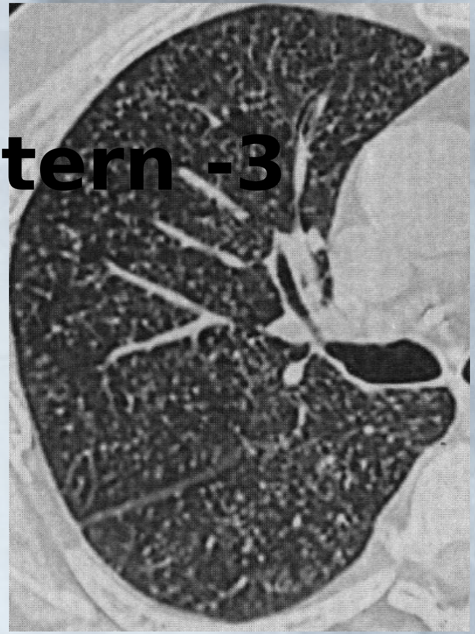
**Pulmonary nodule -1**

**Airspace nodule -2**

**Part of an underlying reticulonodule pattern -3**

**:Causes**

- **Metastation**
- **Miliary T.B**
- **Miliary fungal**
- **sarcoidosis**

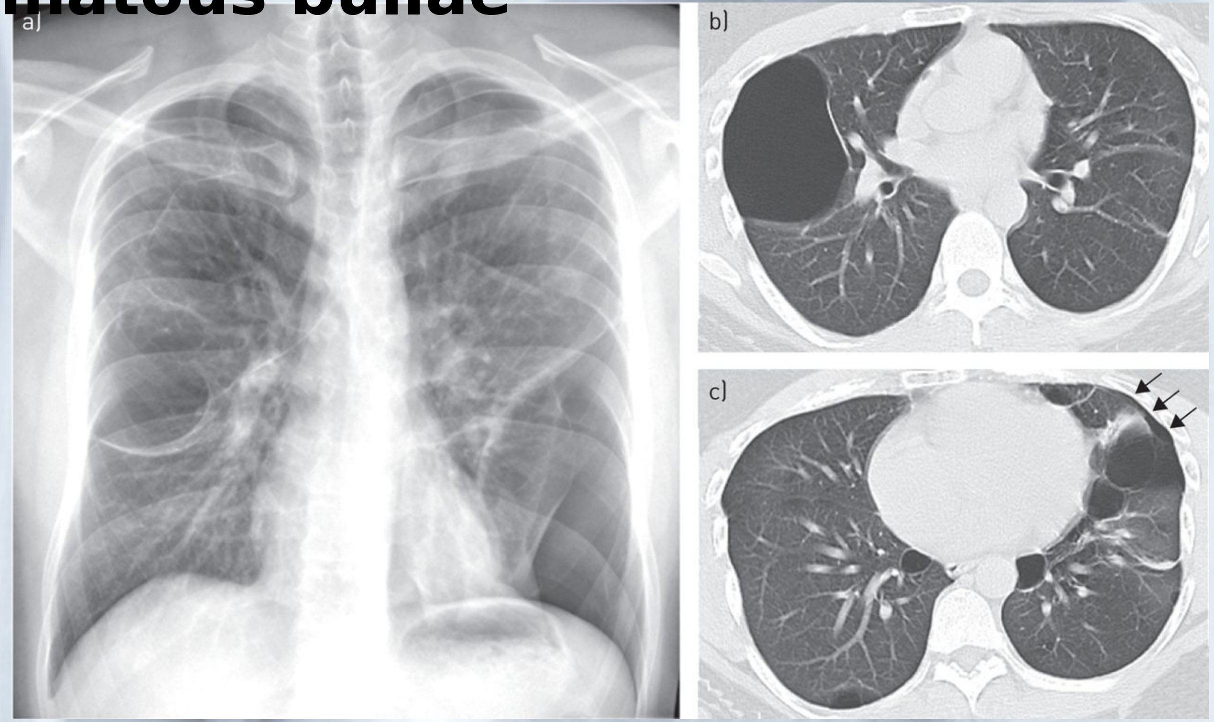


# Cystic-5 pattern

**Cystic pattern is present when multiple well-defined, air-containing spaces (“holes”) are variably scattered throughout the pulmonary parenchyma. The “holes” appear black on CT and white on .pathological specimens**

**:Causes**

**Emphysematous bullae**



Breathing down

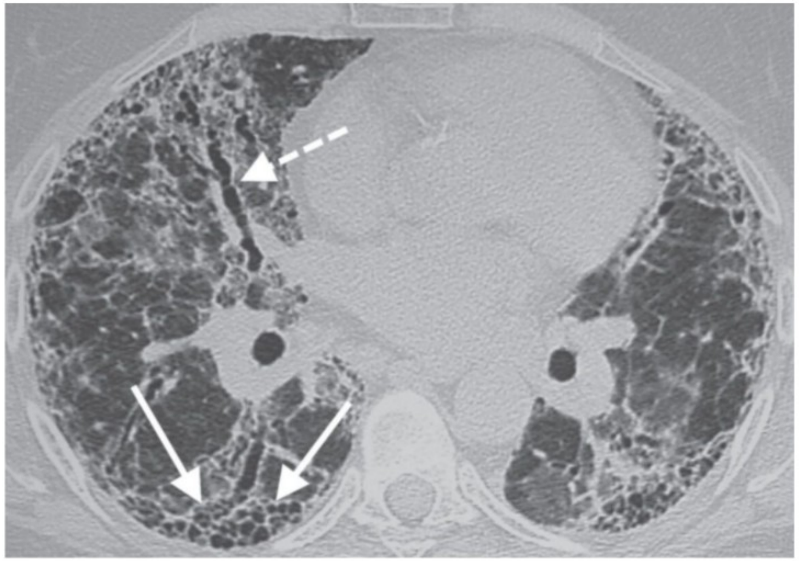
+

**pneumatocele**

Honey-combing

# Honeycomb Pattern

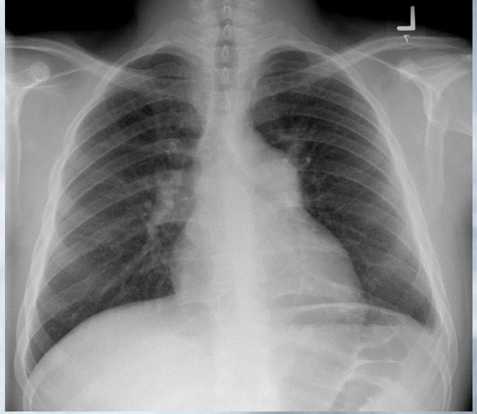
- Honeycombing is characterized by the presence of cystic airspaces with thick, clearly definable fibrous walls lined by bronchiolar epithelium. It results from the destruction of alveoli and loss of acinar architecture and is associated with pulmonary fibrosis. The cysts are typically layered along the pleural surface, helping to distinguish them from the nonlayered subpleural lucencies seen with paraseptal emphyse
- **Honeycomb pattern.** CT shows layers of subpleural cysts (*solid arrows*) representing the honeycomb pattern of pulmonary fibrosis. Also shown is traction bronchiectasis (*dashed arrow*), another sign of pulmonary fibrosis.



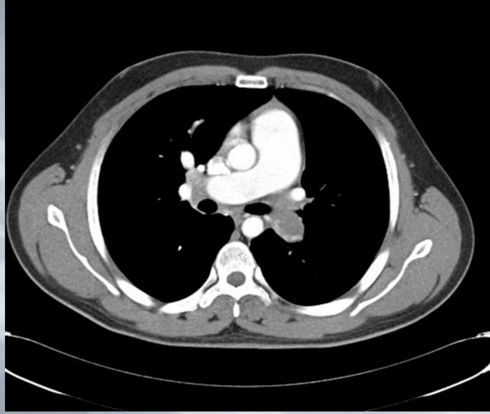
# v. Common debates AND findings

| Clinical/ diagnostic problem | Investigation | Recommendation | comment |
|---|---|---|---|
| **IV- Suspected pulmonary embolism** | CXR | Indicated | • Useful to exclude other causes of acute chest pain<br>• To assess for consolidation and pleural effusion.<br>• Normal CXR does not exclude PE. |
| *it is important to use an agreed protocol combining clinical features, D-dimer assay, and corporated venous U/S to exclude thrombo-embolic ds. | CTPA | indicated | • Investigation of choice in high risk patients or those with moderate risk but positive D dimer.<br>• Easy and quick to perform with sensitivity to diagnose PE<br>• Allows diagnosis of alternative causes pain, assessment of right ventricle and main pulmonary artery. |
| | NM (ventilation/perfusion scintigraphy) | Indicated | • Alternative to CTPA used in young patients with no pre-existing thrombo-embolic ds.<br>• Useful in pregnant patients since it has lower dose than CTPA<br>• It is useful in patients with chronic PE. |
| | MRI | Indicated | • MRPA is useful when CTPA is contr-indicated and V/Q scan is not helpful in the presence of abnormal CXR. |

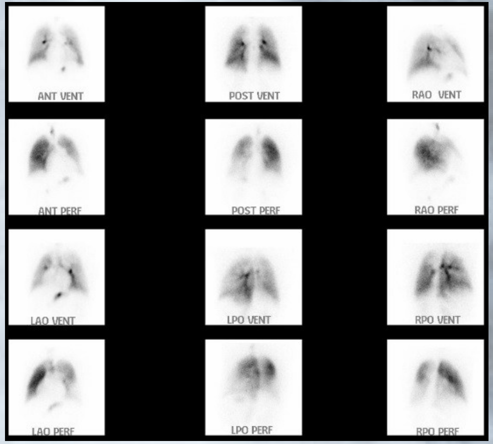
As it is an emergency performed without renal function test and for pregnant women



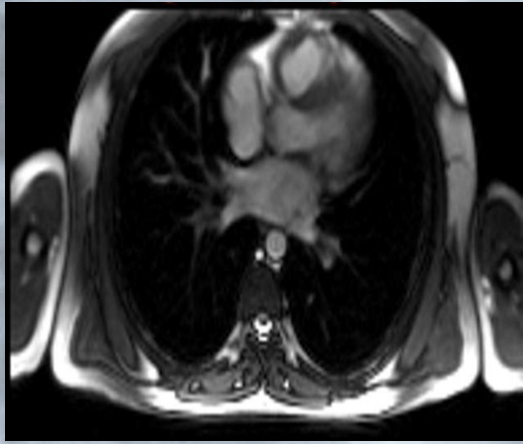
Enlarged pulmonary trunk, lungs and pleural spaces are clear



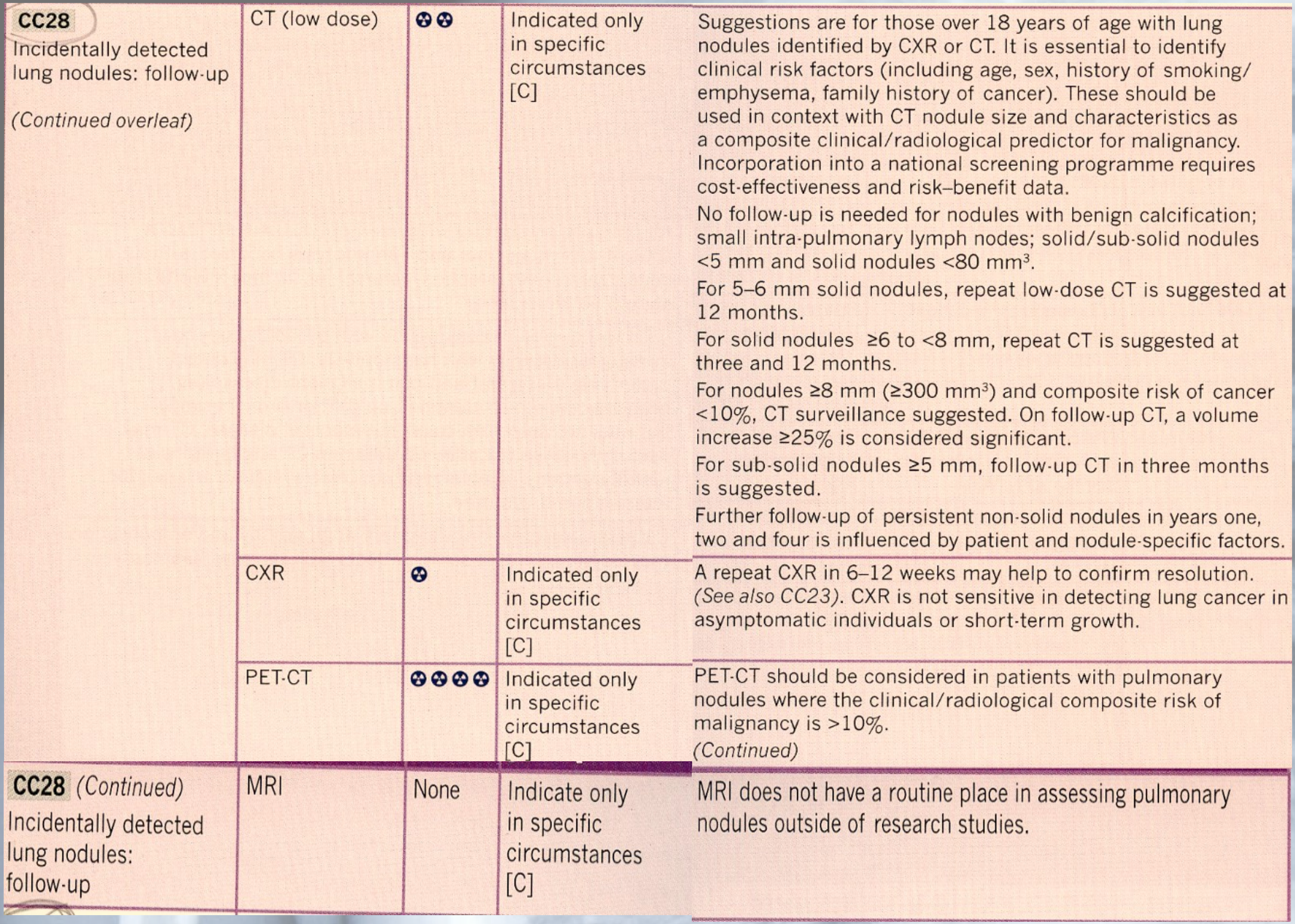
Bilateral pulmonary .arteries emboli



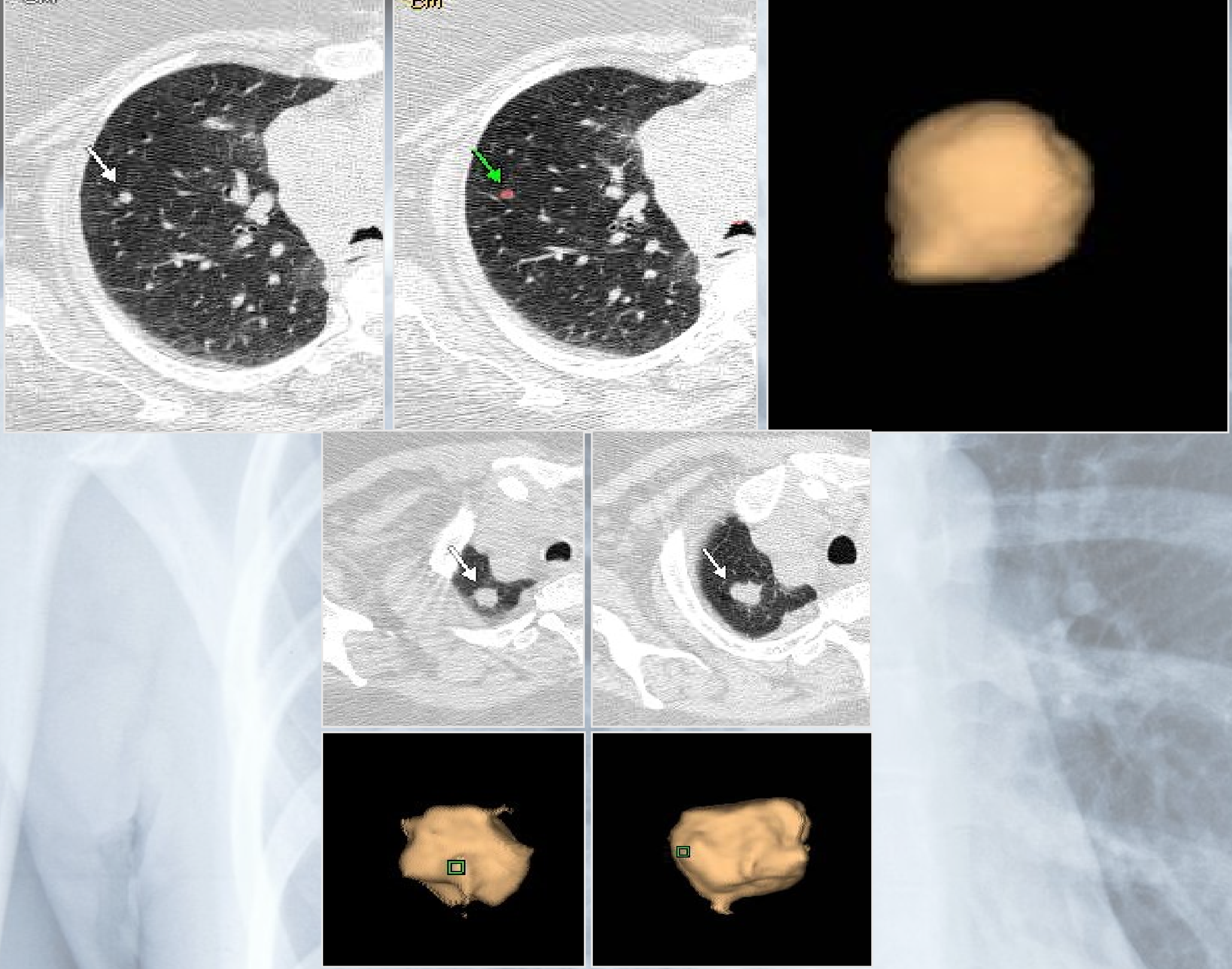
Bilateral major mismatch (ventilation perfusion study )



Bilateral segmental pulmonary arteries emboli.

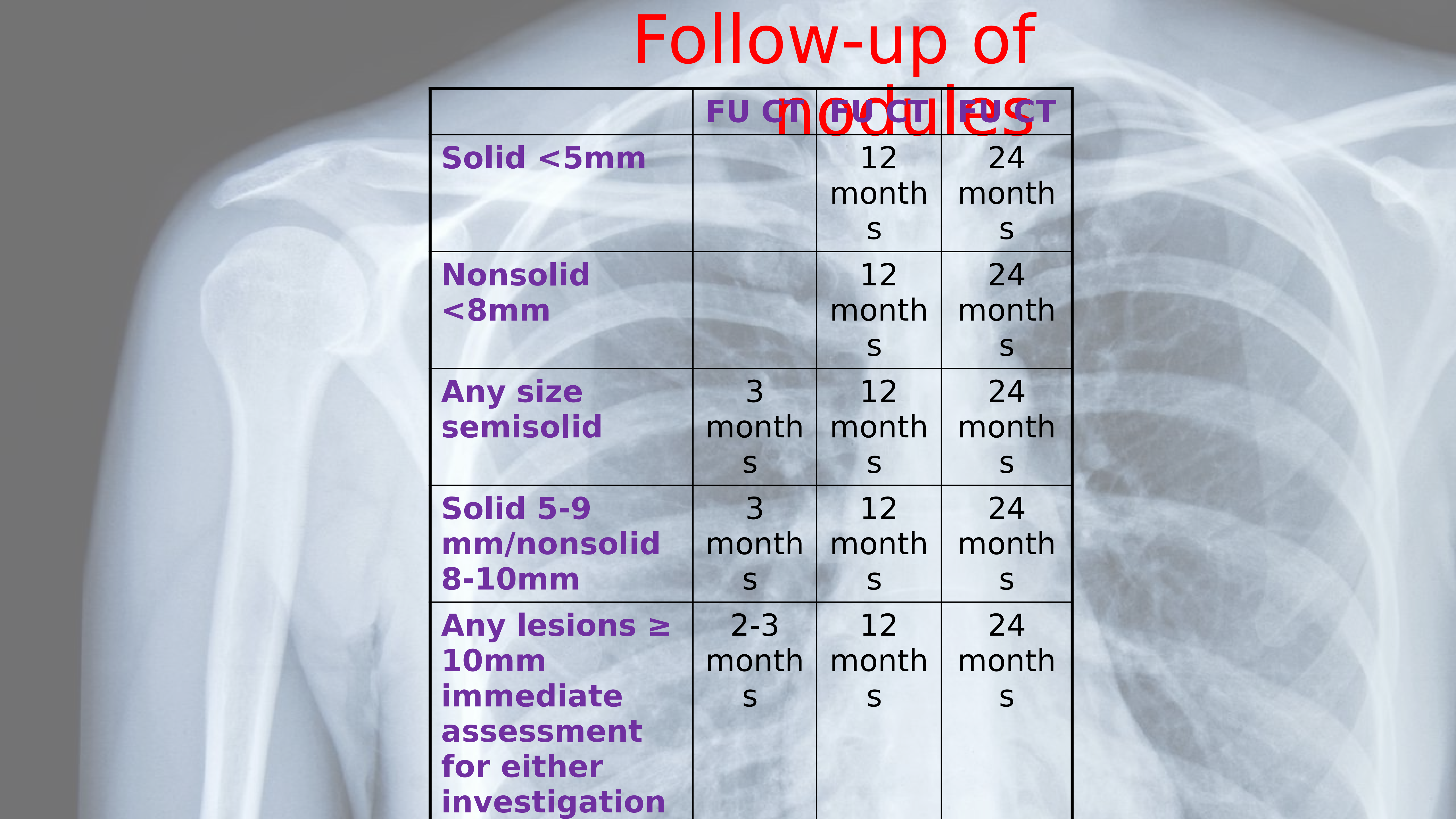


| | | | | |
|---|---|---|---|---|
| **CC28**<br>Incidentally detected lung nodules: follow-up<br>*(Continued overleaf)* | CT (low dose) | ☢☢ | Indicated only in specific circumstances [C] | Suggestions are for those over 18 years of age with lung nodules identified by CXR or CT. It is essential to identify clinical risk factors (including age, sex, history of smoking/emphysema, family history of cancer). These should be used in context with CT nodule size and characteristics as a composite clinical/radiological predictor for malignancy. Incorporation into a national screening programme requires cost-effectiveness and risk–benefit data.<br>No follow-up is needed for nodules with benign calcification; small intra-pulmonary lymph nodes; solid/sub-solid nodules <5 mm and solid nodules <80 mm$^3$.<br>For 5–6 mm solid nodules, repeat low-dose CT is suggested at 12 months.<br>For solid nodules ≥6 to <8 mm, repeat CT is suggested at three and 12 months.<br>For nodules ≥8 mm (≥300 mm$^3$) and composite risk of cancer <10%, CT surveillance suggested. On follow-up CT, a volume increase ≥25% is considered significant.<br>For sub-solid nodules ≥5 mm, follow-up CT in three months is suggested.<br>Further follow-up of persistent non-solid nodules in years one, two and four is influenced by patient and nodule-specific factors. |
| | CXR | ☢ | Indicated only in specific circumstances [C] | A repeat CXR in 6–12 weeks may help to confirm resolution. *(See also CC23)*. CXR is not sensitive in detecting lung cancer in asymptomatic individuals or short-term growth. |
| | PET-CT | ☢☢☢☢ | Indicated only in specific circumstances [C] | PET-CT should be considered in patients with pulmonary nodules where the clinical/radiological composite risk of malignancy is >10%.<br>*(Continued)* |
| **CC28** *(Continued)*<br>Incidentally detected lung nodules: follow-up | MRI | None | Indicate only in specific circumstances [C] | MRI does not have a routine place in assessing pulmonary nodules outside of research studies. |



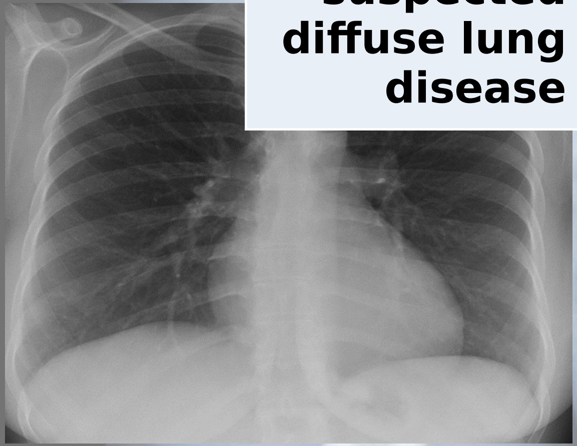
# Lung Volume Computer Assisted Reading

# Follow-up of nodules

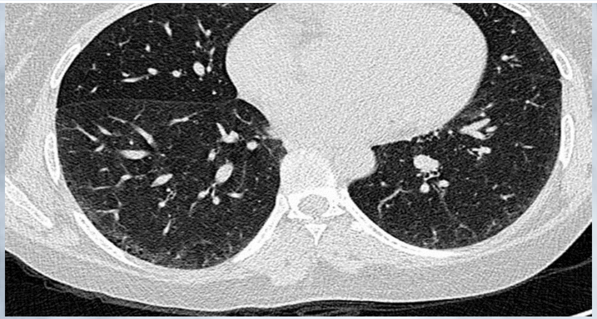


| | **FU CT** | **FU CT** | **FU CT** |
|---|---|---|---|
| **Solid <5mm** | | 12 months | 24 months |
| **Nonsolid <8mm** | | 12 months | 24 months |
| **Any size semisolid** | 3 months | 12 months | 24 months |
| **Solid 5-9 mm/nonsolid 8-10mm** | 3 months | 12 months | 24 months |
| **Any lesions ≥ 10mm immediate assessment for either investigation** | 2-3 months | 12 months | 24 months |

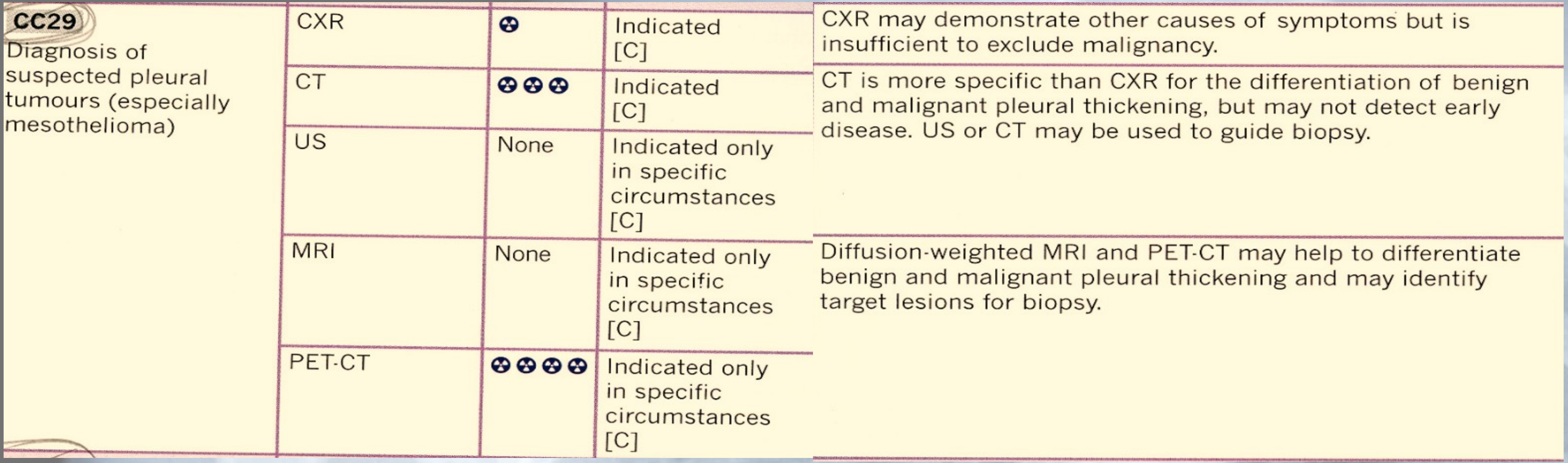
| Clinical/ diagnostic problem | Investigation | Recommendation | comment |
|---|---|---|---|
| **XI-Hemoptysis** | CXR | Indicated | - All patients with hemoptysis should have CXR. If normal then proceed to .other modalities<br>- CT (including CT angio) may be used in conjunction with bronchoscopy to detect underlying malignant and .non-malignant diseases<br>- Catheter bronchial angiography with or without embolization may be life saving in patients with massive .hemoptysis |
| | CT | indicated | |
| | Bronchial angiography +/- embolization | Indicated in specific .circumstances | |
| **XII-suspected diffuse lung disease** | CT | Indicated | - Although CXR can be used but HRCT is better performed to confirm suspected diffuse infiltrative lung .diseases |



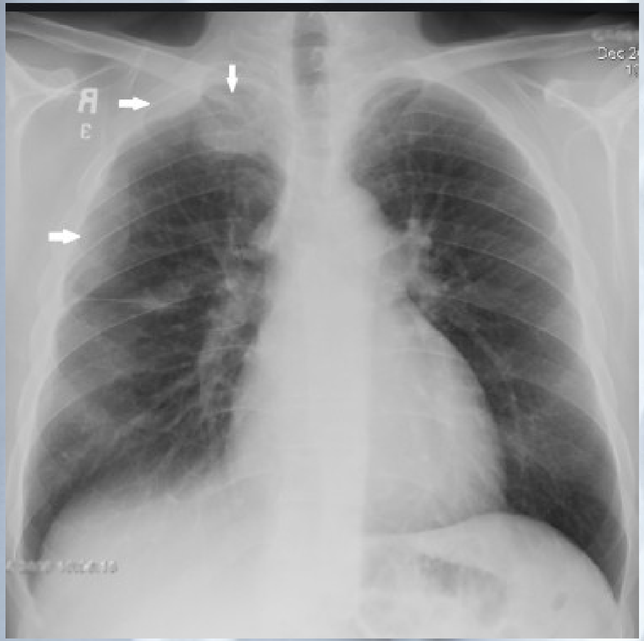
X-Ray
Chest radiograph
shows no
significant
.abnormality

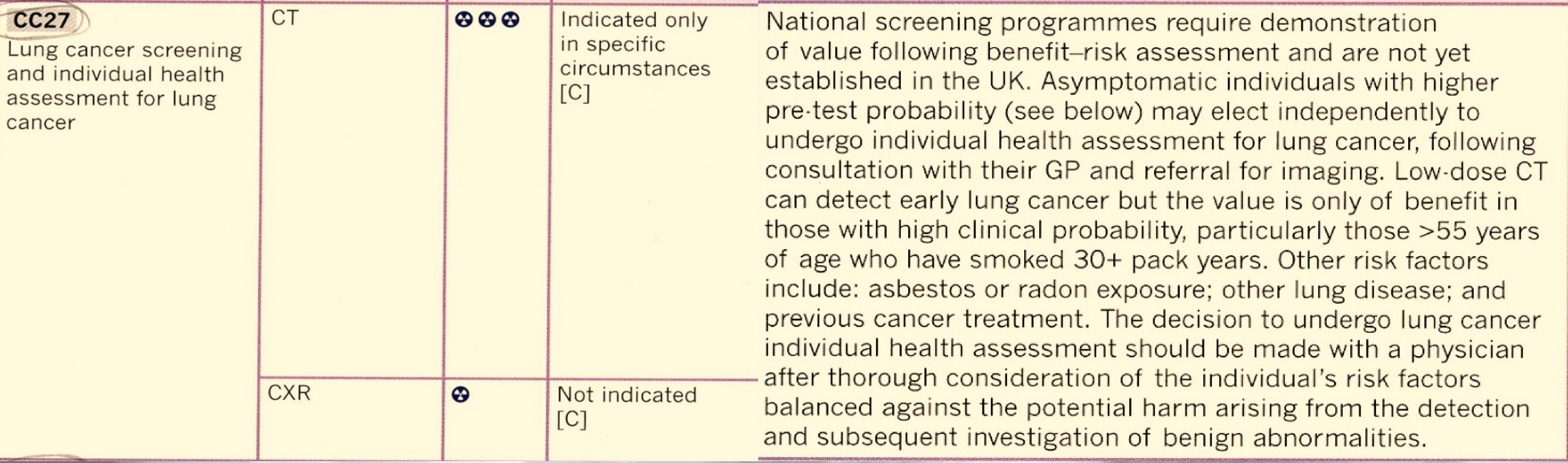


CT
lly symmetrical
fine reticular opacities
with relative subpleural
sparing, microcystic
abnormalities and mild
ground glass opacities
with lower lobe



| | | | | |
|---|---|---|---|---|
| **CC29**<br>Diagnosis of suspected pleural tumours (especially mesothelioma) | CXR | ☢ | Indicated [C] | CXR may demonstrate other causes of symptoms but is insufficient to exclude malignancy. |
| | CT | ☢☢☢ | Indicated [C] | CT is more specific than CXR for the differentiation of benign and malignant pleural thickening, but may not detect early disease. US or CT may be used to guide biopsy. |
| | US | None | Indicated only in specific circumstances [C] | |
| | MRI | None | Indicated only in specific circumstances [C] | Diffusion-weighted MRI and PET-CT may help to differentiate benign and malignant pleural thickening and may identify target lesions for biopsy. |
| | PET-CT | ☢☢☢☢ | Indicated only in specific circumstances [C] | |

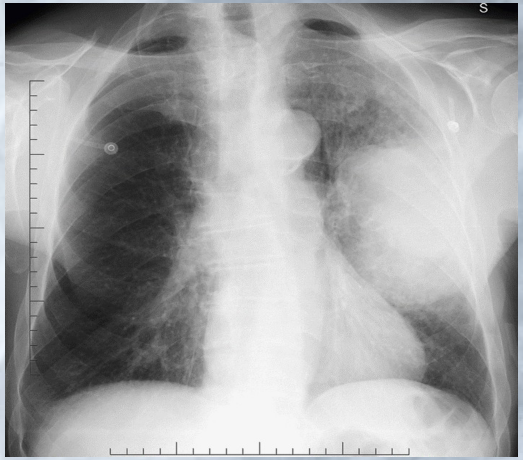




| | | | | |
|---|---|---|---|---|
| **CC27**<br>Lung cancer screening and individual health assessment for lung cancer | CT | ☢☢☢ | Indicated only in specific circumstances [C] | National screening programmes require demonstration of value following benefit–risk assessment and are not yet established in the UK. Asymptomatic individuals with higher pre-test probability (see below) may elect independently to undergo individual health assessment for lung cancer, following consultation with their GP and referral for imaging. Low-dose CT can detect early lung cancer but the value is only of benefit in those with high clinical probability, particularly those >55 years of age who have smoked 30+ pack years. Other risk factors include: asbestos or radon exposure; other lung disease; and previous cancer treatment. The decision to undergo lung cancer individual health assessment should be made with a physician after thorough consideration of the individual's risk factors balanced against the potential harm arising from the detection and subsequent investigation of benign abnormalities. |
| | CXR | ☢ | Not indicated [C] | |

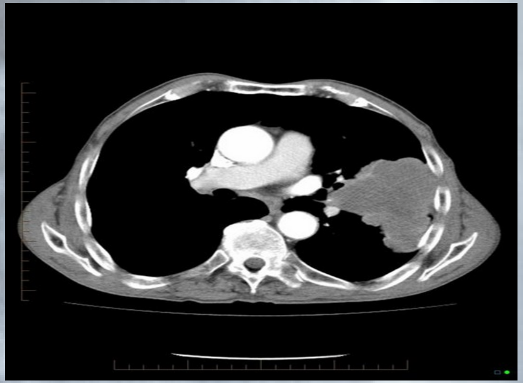
X-Ray

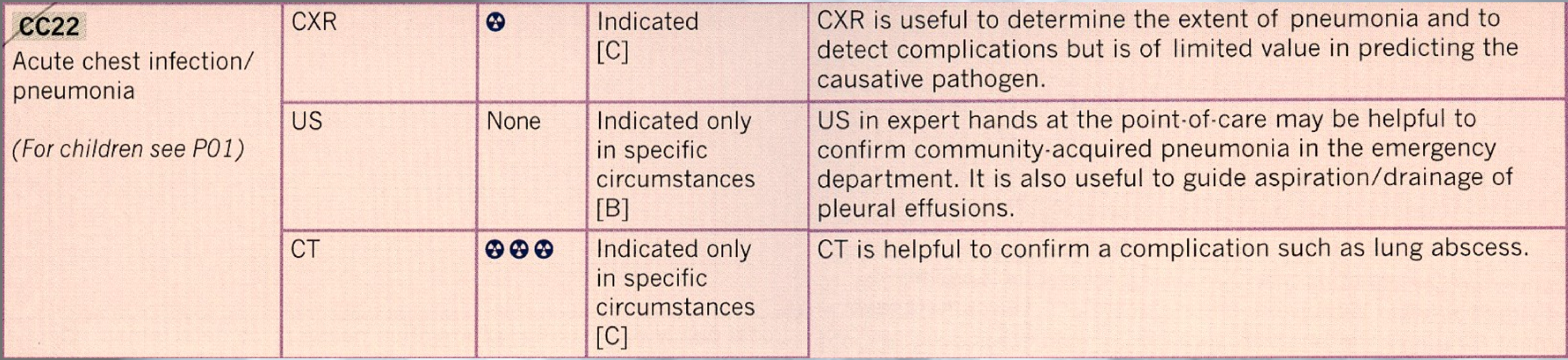
Chest x-ray demonstrates a large left sided midzone mass, with lobulated margins. There is no convincing extension beyond the chest wall and the remainder of the chest, other than a degree of hyperinflation, appears .unremarkable



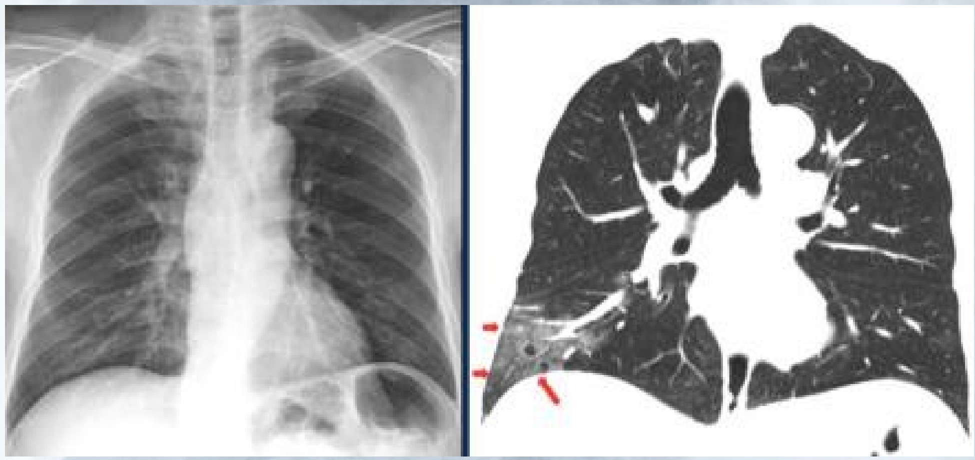
CT

CT confirms the findings. Only a few small mediastinal nodes are present, and no other parenchymal mass .is identified

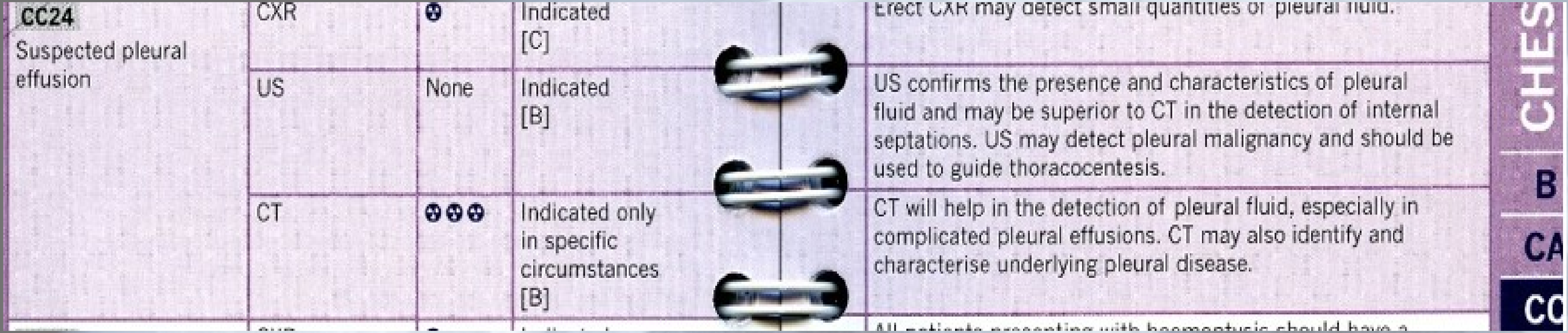




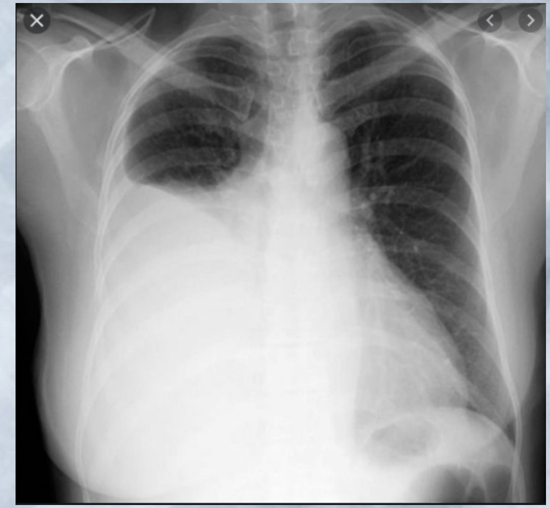
| | | | | |
|---|---|---|---|---|
| **CC22**<br>Acute chest infection/ pneumonia<br>*(For children see P01)* | CXR | ☢ | Indicated [C] | CXR is useful to determine the extent of pneumonia and to detect complications but is of limited value in predicting the causative pathogen. |
| | US | None | Indicated only in specific circumstances [B] | US in expert hands at the point-of-care may be helpful to confirm community-acquired pneumonia in the emergency department. It is also useful to guide aspiration/drainage of pleural effusions. |
| | CT | ☢☢☢ | Indicated only in specific circumstances [C] | CT is helpful to confirm a complication such as lung abscess. |

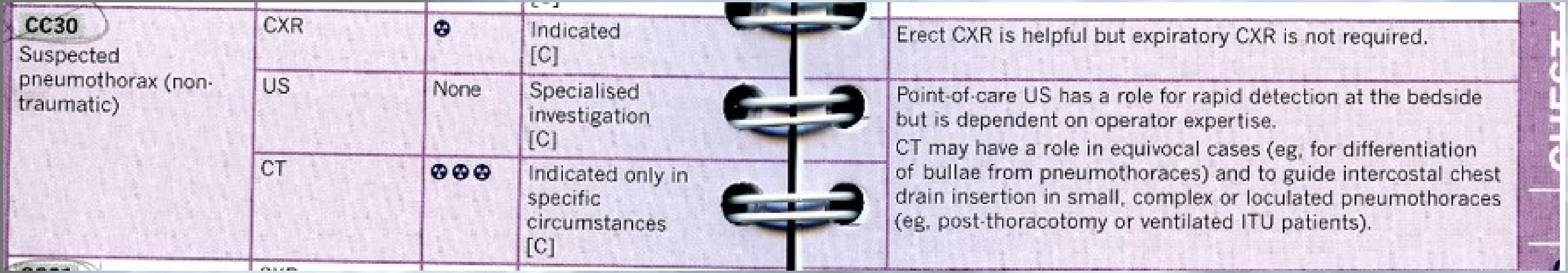


Ground glass opacity
( GGO )

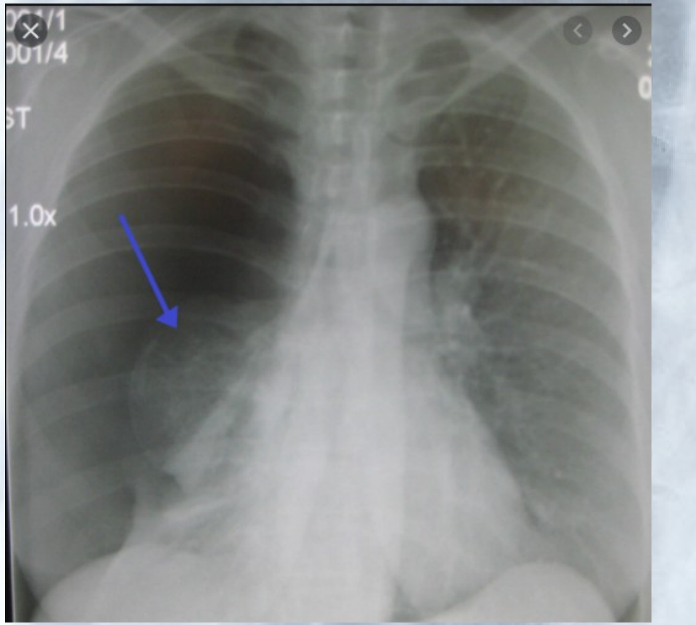


| | | | | |
|---|---|---|---|---|
| **CC24**<br>Suspected pleural effusion | CXR | ☢ | Indicated<br>[C] | Erect CXR may detect small quantities of pleural fluid. |
| | US | None | Indicated<br>[B] | US confirms the presence and characteristics of pleural fluid and may be superior to CT in the detection of internal septations. US may detect pleural malignancy and should be used to guide thoracocentesis. |
| | CT | ☢☢☢ | Indicated only in specific circumstances<br>[B] | CT will help in the detection of pleural fluid, especially in complicated pleural effusions. CT may also identify and characterise underlying pleural disease. |



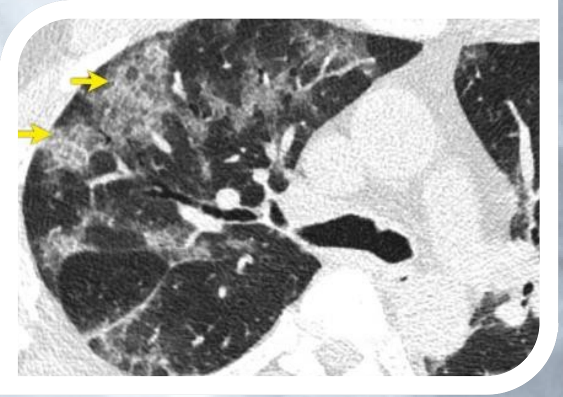


| | | | | |
|---|---|---|---|---|
| **CC30**<br>Suspected pneumothorax (non-traumatic) | CXR | ☢ | Indicated<br>[C] | Erect CXR is helpful but expiratory CXR is not required. |
| | US | None | Specialised investigation<br>[C] | Point-of-care US has a role for rapid detection at the bedside but is dependent on operator expertise.<br>CT may have a role in equivocal cases (eg, for differentiation of bullae from pneumothoraces) and to guide intercostal chest drain insertion in small, complex or loculated pneumothoraces (eg, post-thoracotomy or ventilated ITU patients). |
| | CT | ☢☢☢ | Indicated only in specific circumstances<br>[C] | |



## A-Crazy paving

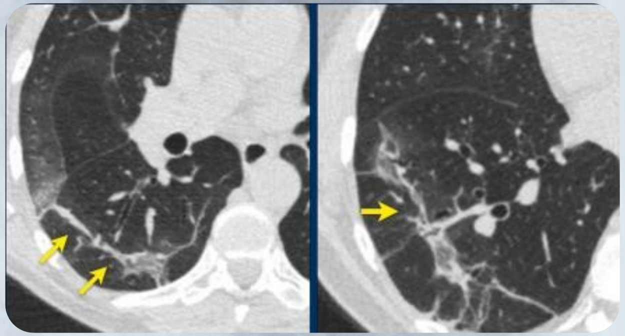
Sometimes there are thickened interlobular and intra-lobular lines in
.combination with a ground glass pattern. This is called crazy paving
.It is believed that this pattern is seen in a somewhat later stage -



## B-Vascular dilatation

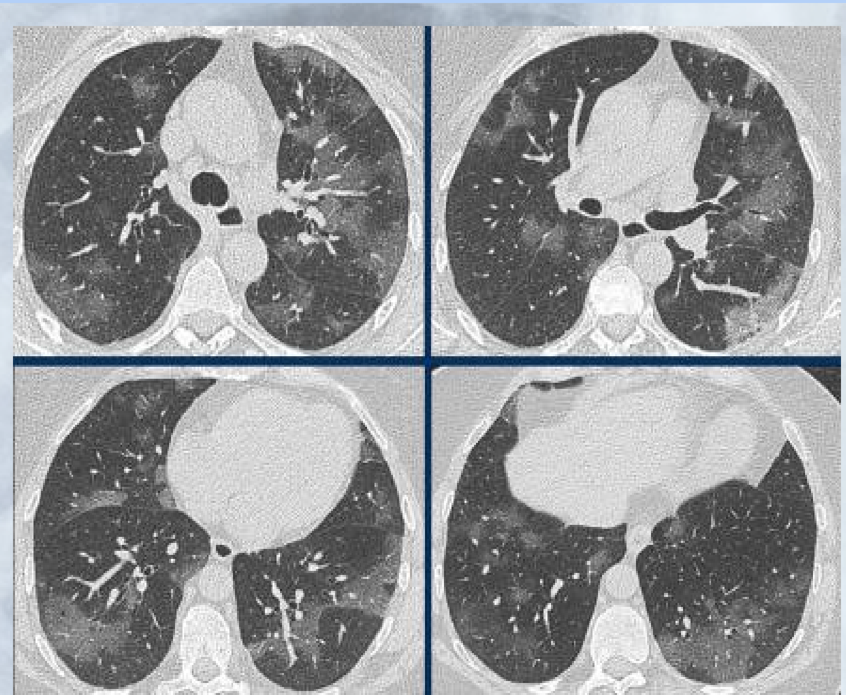
## C-Traction Bronchiectasis

## ub-pleural bands and Architectural distortion



# intitial CT-patterns in COVID-19

| | |
|---|---|
| Ground-glass opacification | 88% |
| Bilateral involvement | 88% |
| Posterior distribution | 80% |
| Multilobar involvement | 79% |
| Peripheral distribution | 76% |
| Consolidation | 32% |



## Chest CT Severity Score Assessment

We developed a chest CT severity score (CT-SS) for assessing COVID-19 burden on the initial scan obtained at admission. This score uses lung opacification as a surrogate for extension of the disease in the lungs. The CT-SS is an adaptation of a method previously used to describe ground-glass opacity, interstitial opacity, and air trapping, which was correlated with clinical and laboratory parameters in patients after SARS . According to the anatomical structure, the 18 segments of both lungs were divided into 20 regions, in which the posterior apical segment of the left upper lobe was subdivided into apical and posterior segmental regions, while the anteromedial basal segment of the left lower lobe was subdivided into anterior and basal segmental regions. The lung opacities in all of the 20 lung regions were subjectively evaluated on chest CT using a system attributing scores of 0, 1, and 2 if parenchymal opacification involved 0%, less than 50%, or equal or more than 50% of each region. The CT-SS was defined as the sum of the individual scored in the 20 .lung segment regions, which may range from 0 to 40 points

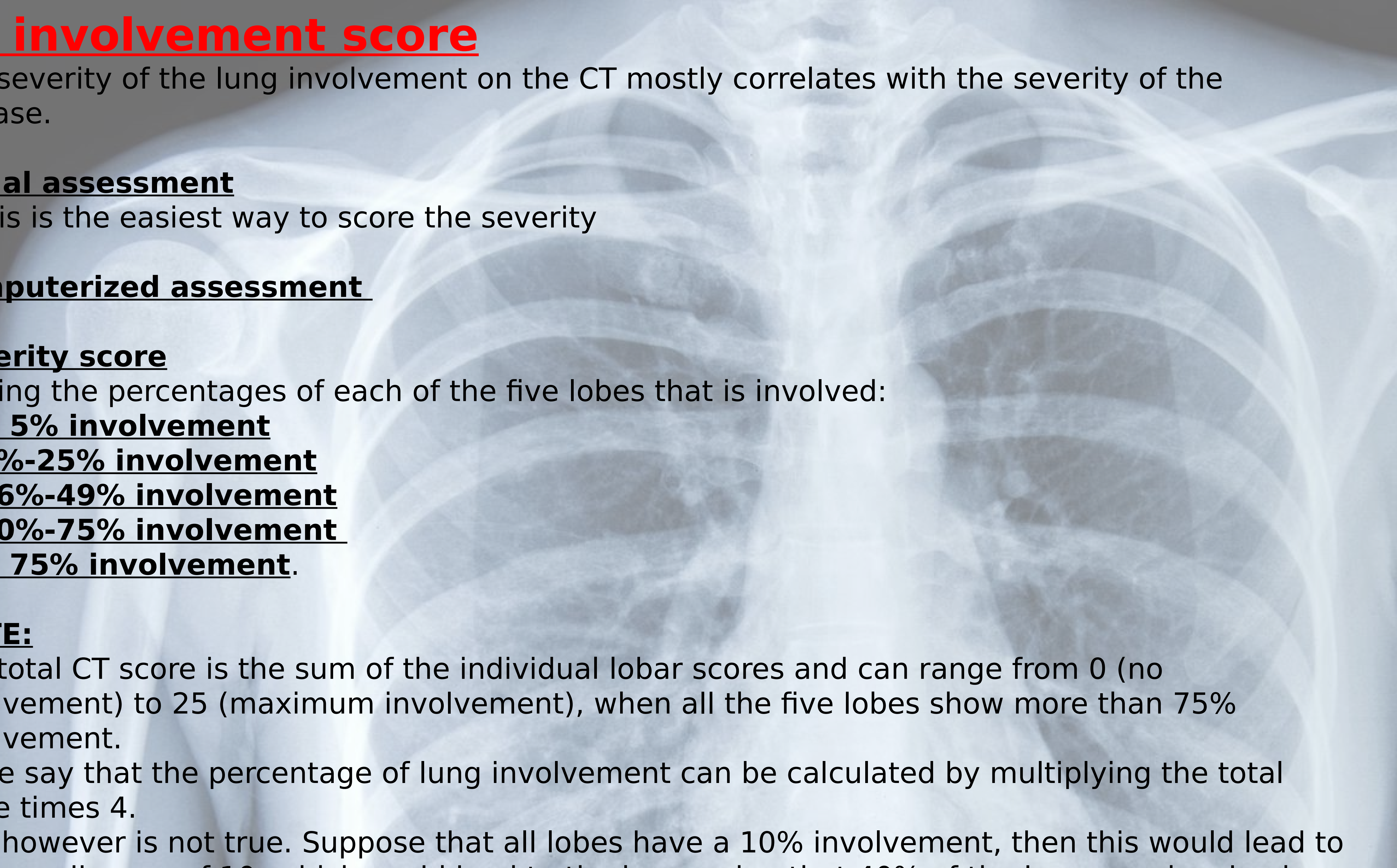
All CT images were independently reviewed by two chest radiologists with more than 10 years of experience, blinded to the clinical data and laboratory indicators, in a standard clinical Picture Archiving and Diagnostic System workstation. All thin-section CT scans were reviewed at a window width and level of 1000 to 2000 HU and -700 to -500 HU, .respectively, for lung parenchyma

The extent of involvement on thin-section CT images was also assessed by the two radiologists. Each side of the lung was divided (from top to bottom) into three zones: the upper zone (above the carina), the middle zone (from the carina to the inferior pulmonary vein), and the lower zone (below the inferior pulmonary vein). Each zone was then divided into two areas: the anterior area (the area before the vertical line of the midpoint of the diaphragm in the sagittal position) and the posterior area (the area after the vertical line of the midpoint of the diaphragm in the sagittal position)

bilateral lungs were divided into 12 zones altogether. The degree of involvement in each lung zone was scored as follows [6–8]: a score of 0 denoted no involvement; 1, < 25% involvement; 2, 25% to less than 50% involvement; 3, 50% to less than 75% involvement; and 4, ≥ 75% involvement. Scores were recorded and summed for each lung zone, with a maximum possible score of 48.

# CT involvement score

The severity of the lung involvement on the CT mostly correlates with the severity of the disease.



## Visual assessment

.- This is the easiest way to score the severity

## Computerized assessment

## Severity score

Scoring the percentages of each of the five lobes that is involved:

**1- < 5% involvement**
**2- 5%-25% involvement**
**3- 26%-49% involvement**
**4- 50%-75% involvement**
**5- > 75% involvement**.

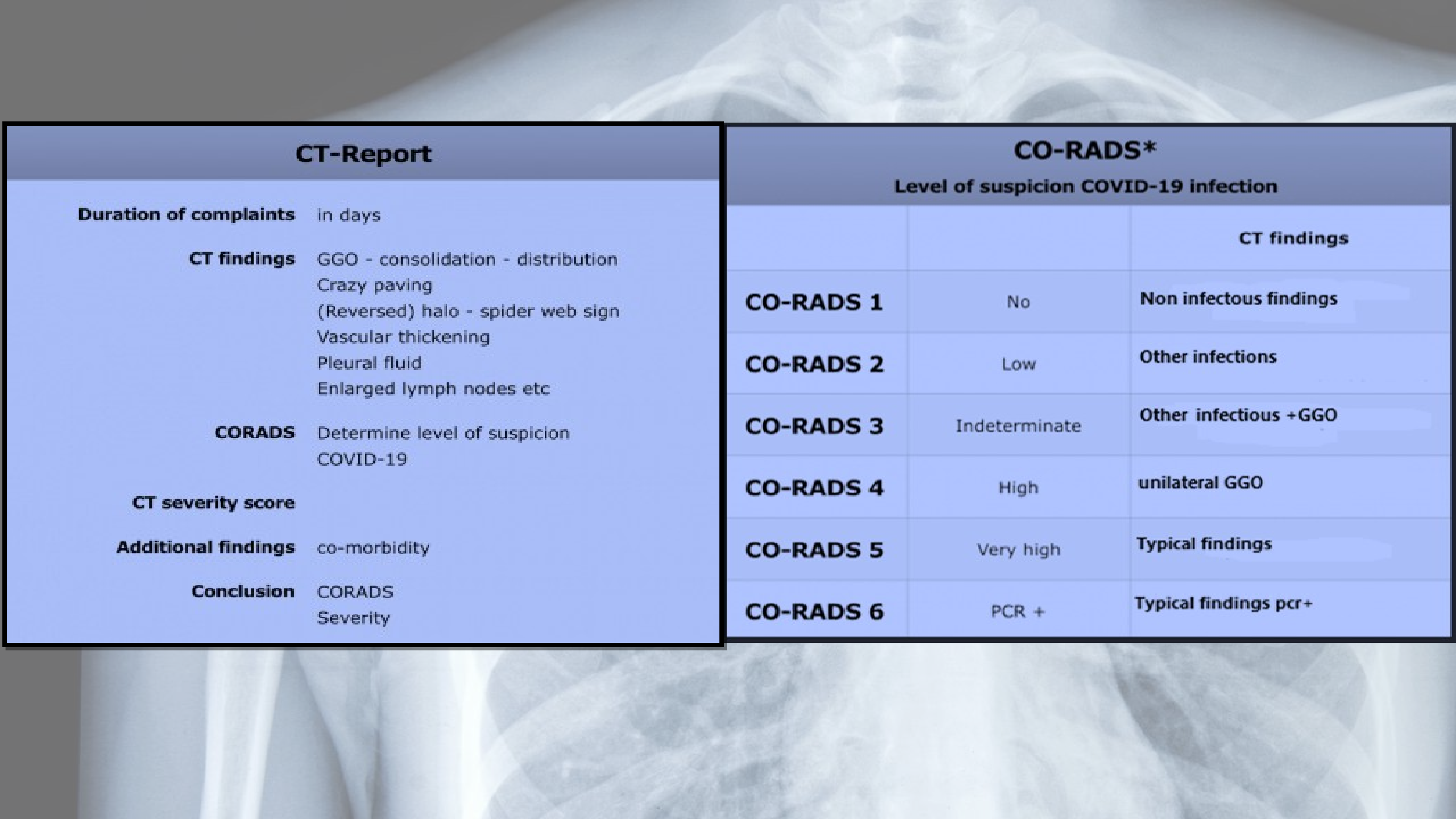
## NOTE:

The total CT score is the sum of the individual lobar scores and can range from 0 (no involvement) to 25 (maximum involvement), when all the five lobes show more than 75% involvement.

Some say that the percentage of lung involvement can be calculated by multiplying the total score times 4.

This however is not true. Suppose that all lobes have a 10% involvement, then this would lead to

# Assessing inflammation burden with volume-rendered chest CT



## CT-Report

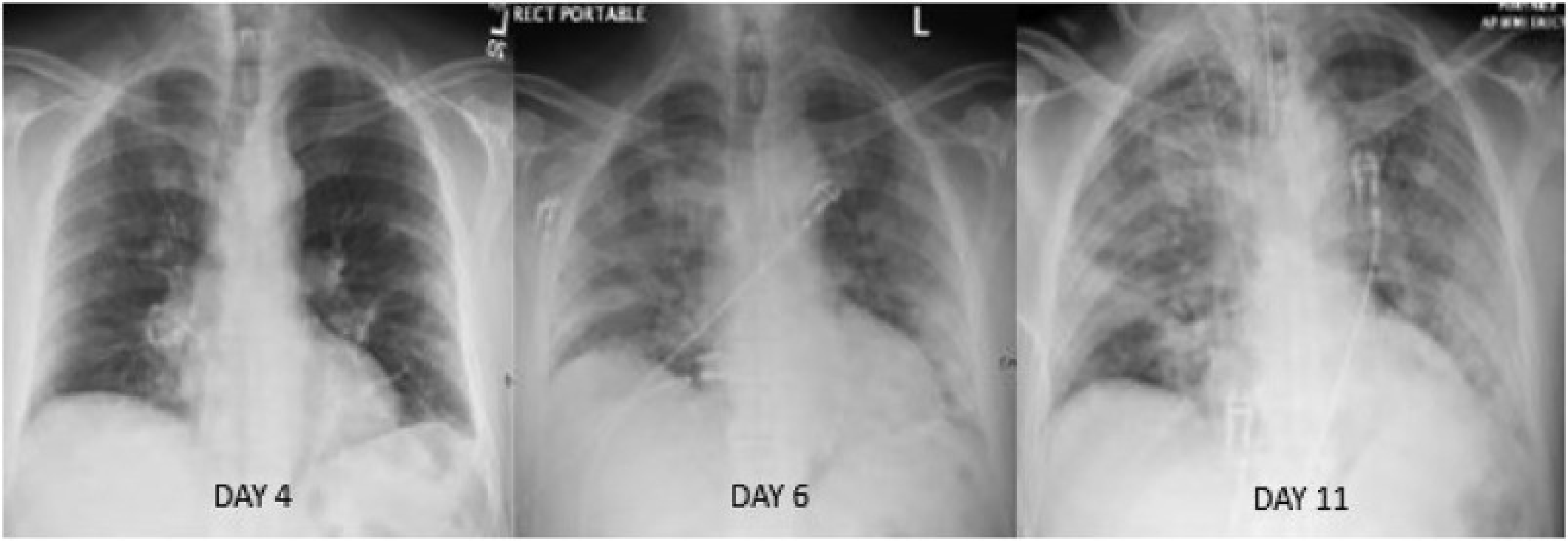
| | |
|---|---|
| **Duration of complaints** | in days |
| **CT findings** | GGO - consolidation - distribution<br>Crazy paving<br>(Reversed) halo - spider web sign<br>Vascular thickening<br>Pleural fluid<br>Enlarged lymph nodes etc |
| **CORADS** | Determine level of suspicion COVID-19 |
| **CT severity score** | |
| **Additional findings** | co-morbidity |
| **Conclusion** | CORADS<br>Severity |

## CO-RADS*

### Level of suspicion COVID-19 infection

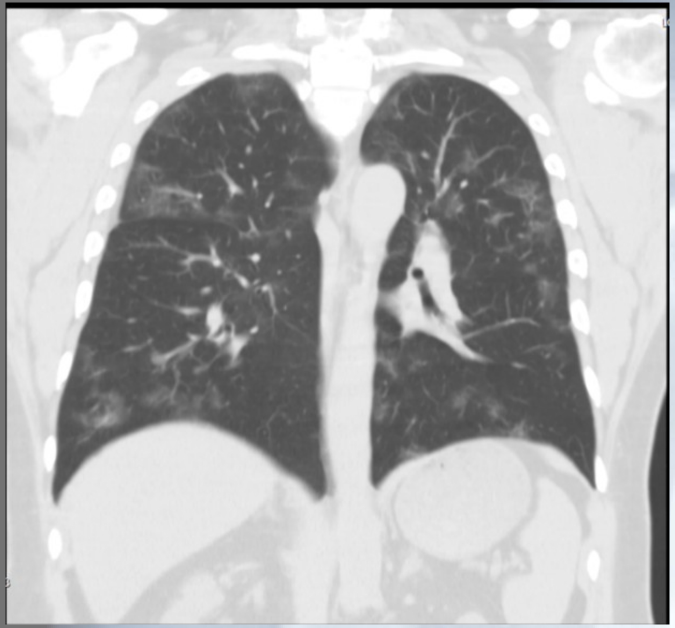
| | | CT findings |
|---|---|---|
| **CO-RADS 1** | No | Non infectous findings |
| **CO-RADS 2** | Low | Other infections |
| **CO-RADS 3** | Indeterminate | Other infectious +GGO |
| **CO-RADS 4** | High | unilateral GGO |
| **CO-RADS 5** | Very high | Typical findings |
| **CO-RADS 6** | PCR + | Typical findings pcr+ |

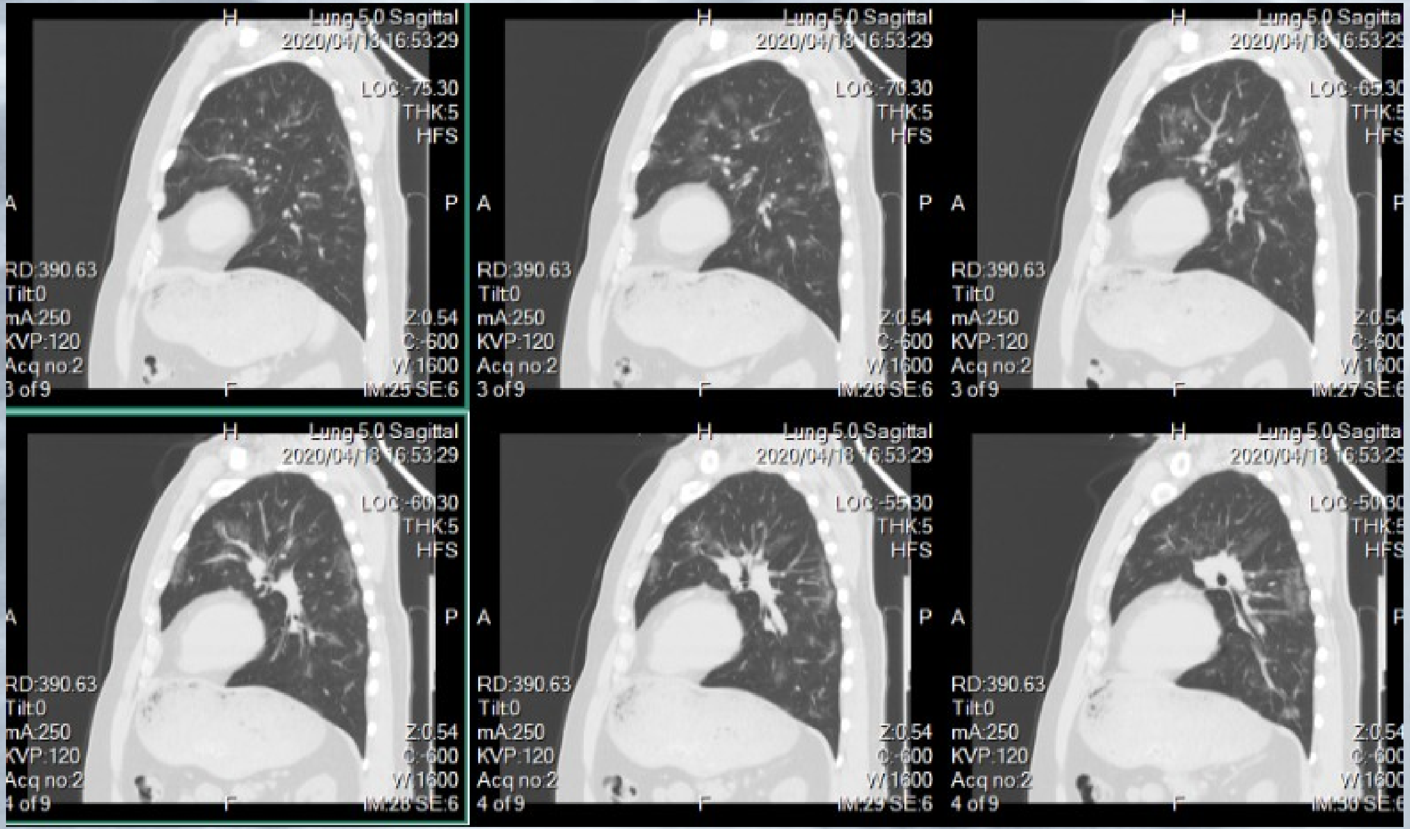
As the pandemic progresses, the medical community will frequently rely on portable CXR due to its widespread availability and reduced infection control issues that currently limit CT utilization.

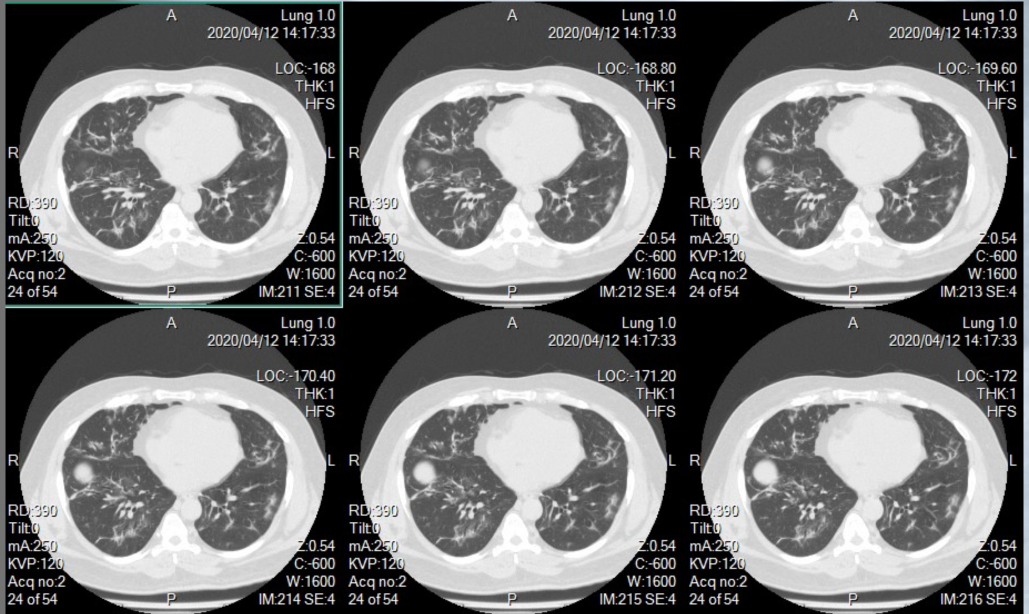


Serial radiographs over 7 days in a patient with COVID-19 infection depicting progression of diffuse lung disease.

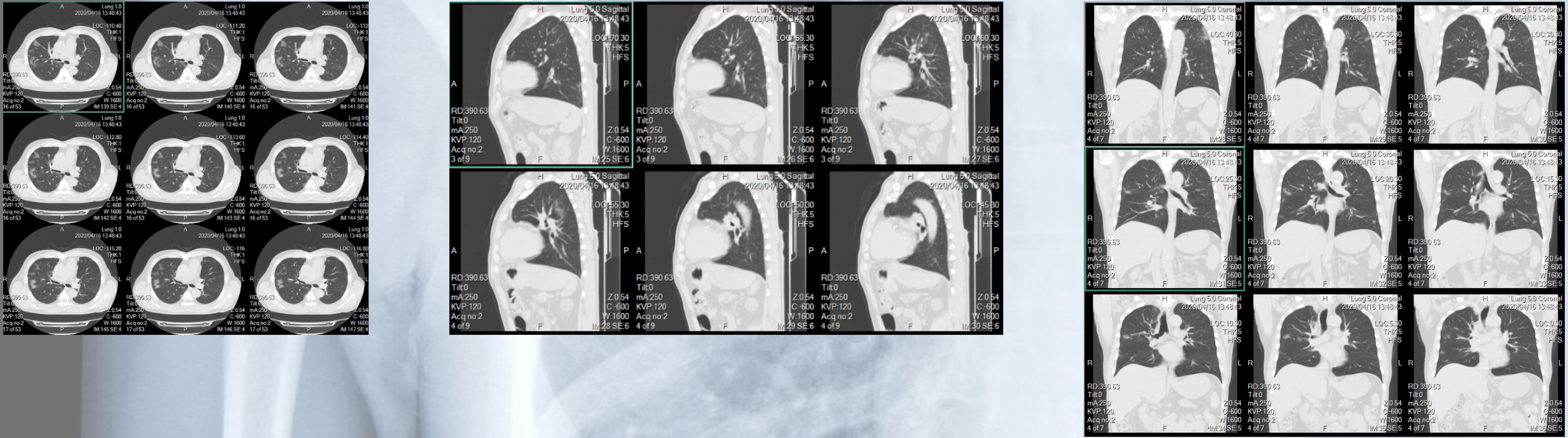
# Co-rad 6 (sever)



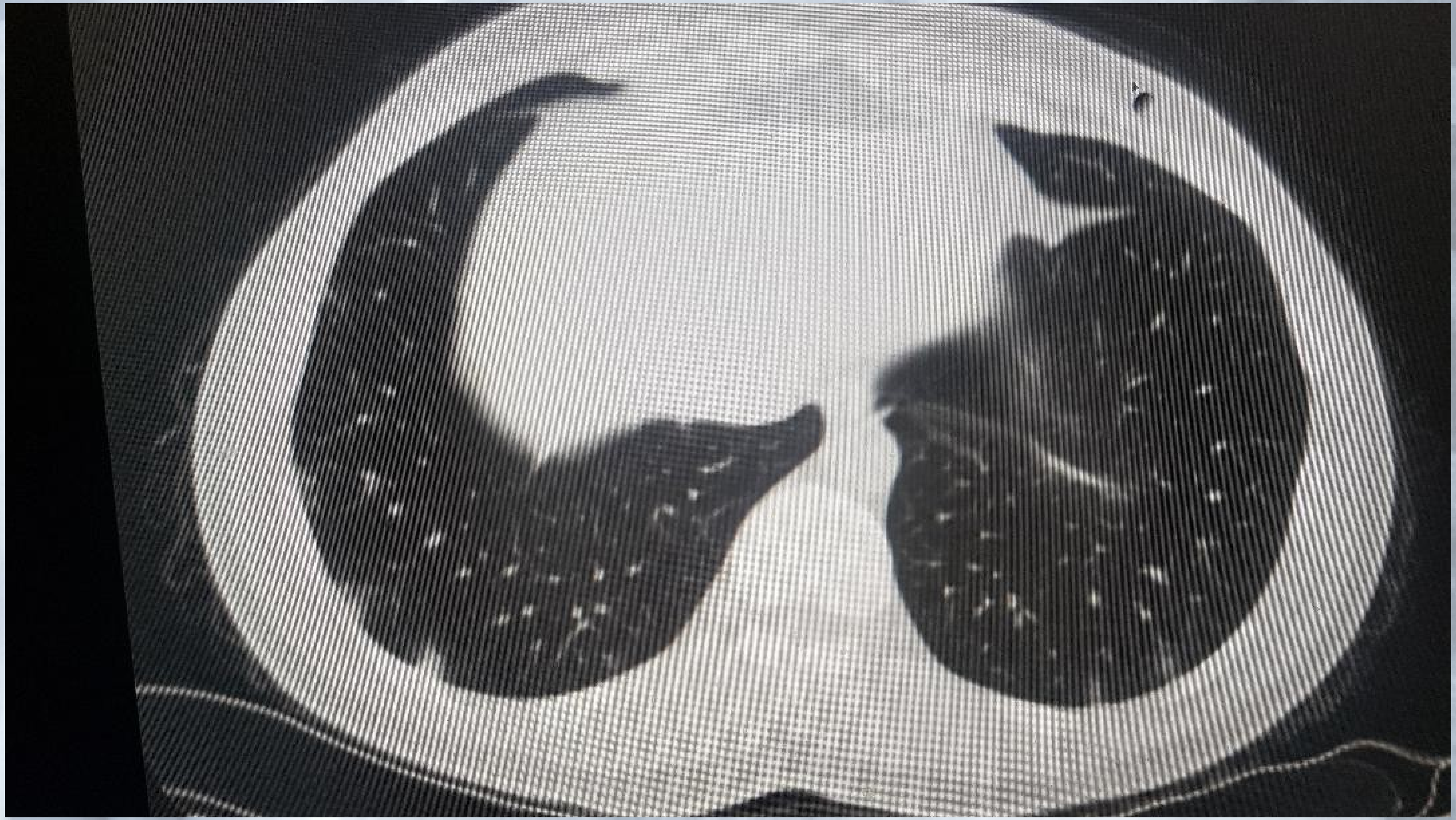




# Classic covid
# Moderate with reversed halo sign



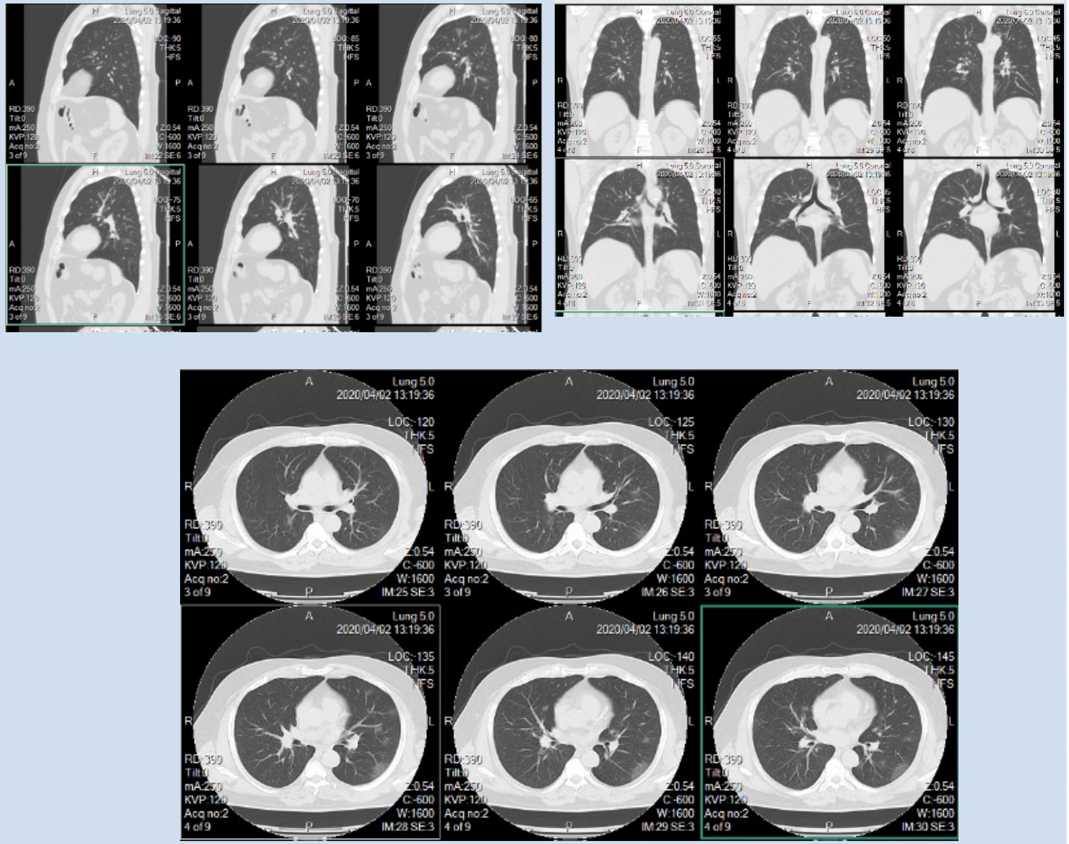
# Classic covid-19 mild (tiny patches)



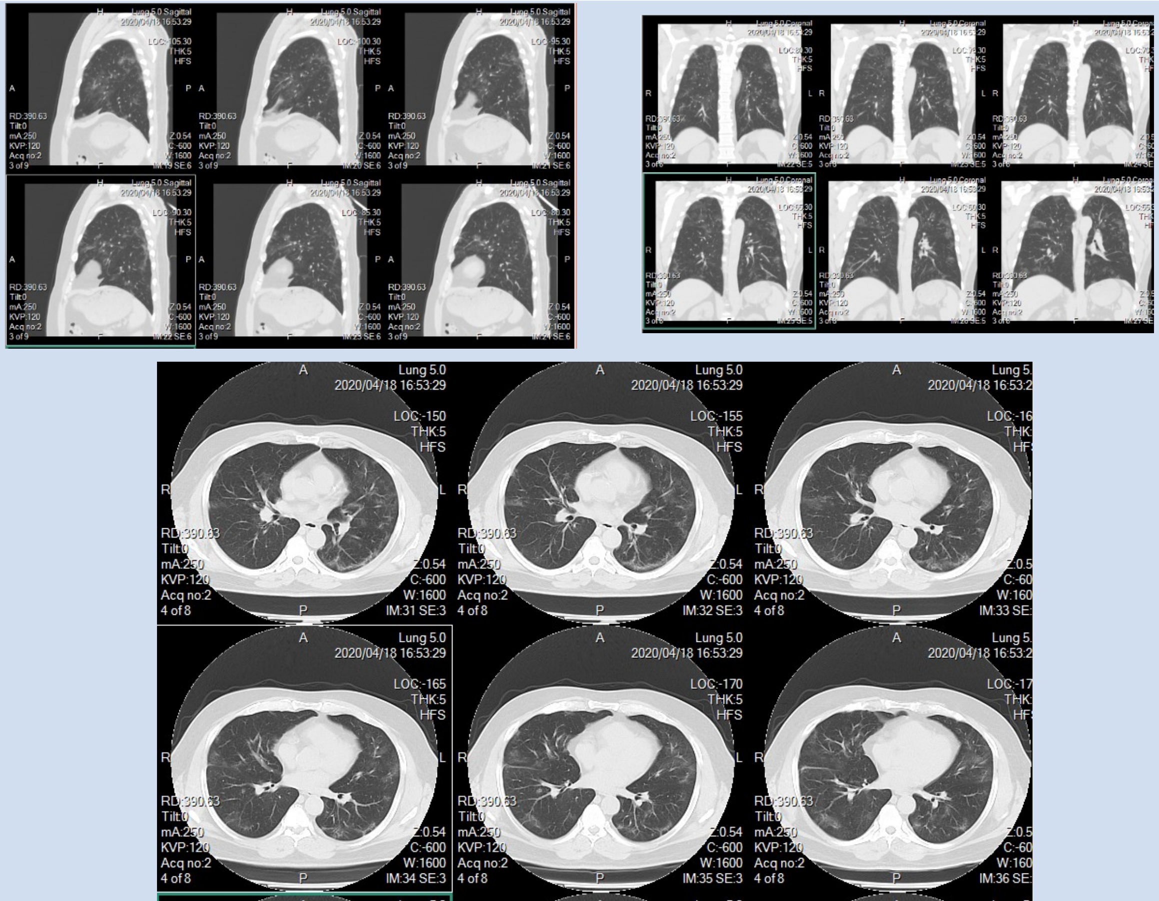
years old male was admitted to hospital on 2/4 with positive PCR, 55 progressive dyspnea. First medication from 2/4 to 13/4( positive PCR) second medication till 18/4 (negative PCR test and clinical improvement)

Bilateral patchy veiling is seen namely peripherally at l.l to lesser extent right U.L impressive of pneumonia ( classic covid19, CORADS 6)……..

CT at 2/4



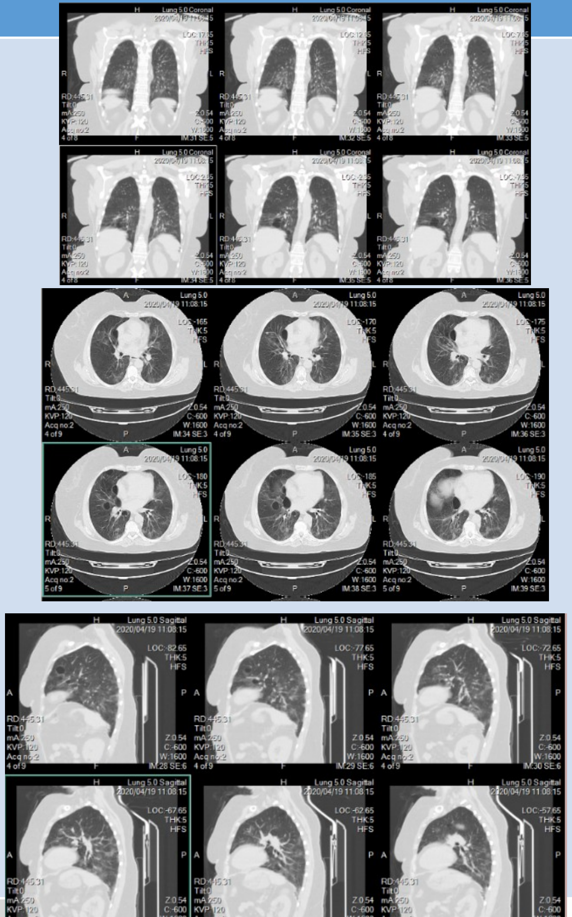
CT at 18/4



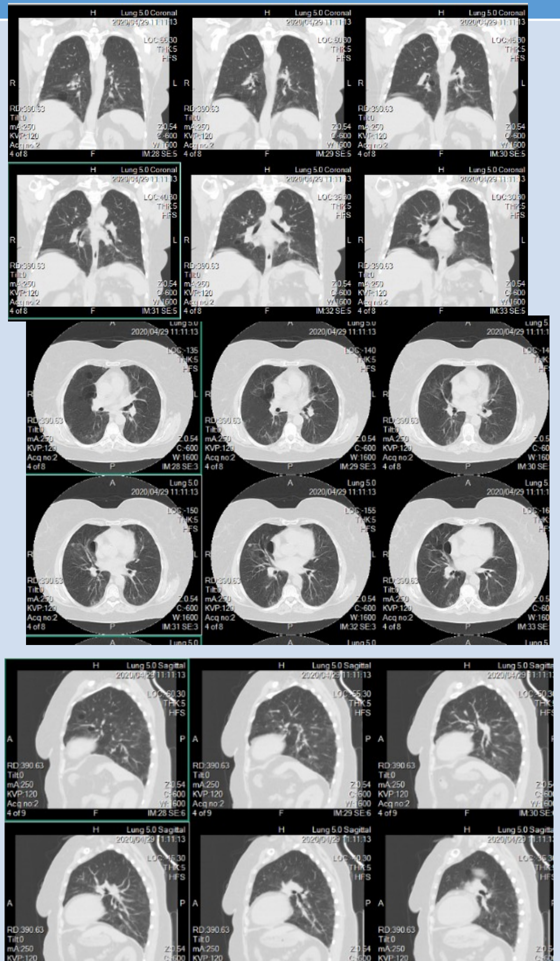
60 years old female was admitted to hospital on 14/4 with positive PCR, fever and dyspnea, started medication 14/4 clinical improvement, (negative PCR test on 27/4 )…….

Bilateral patchy veiling (GGO) is seen namely peripheral L.L and to a lesser extent RT U.L , thin …….. walled dilated air spaces are seen namely at middle a lingula (classic covid19, CORADS 6)

## CT at 19/4



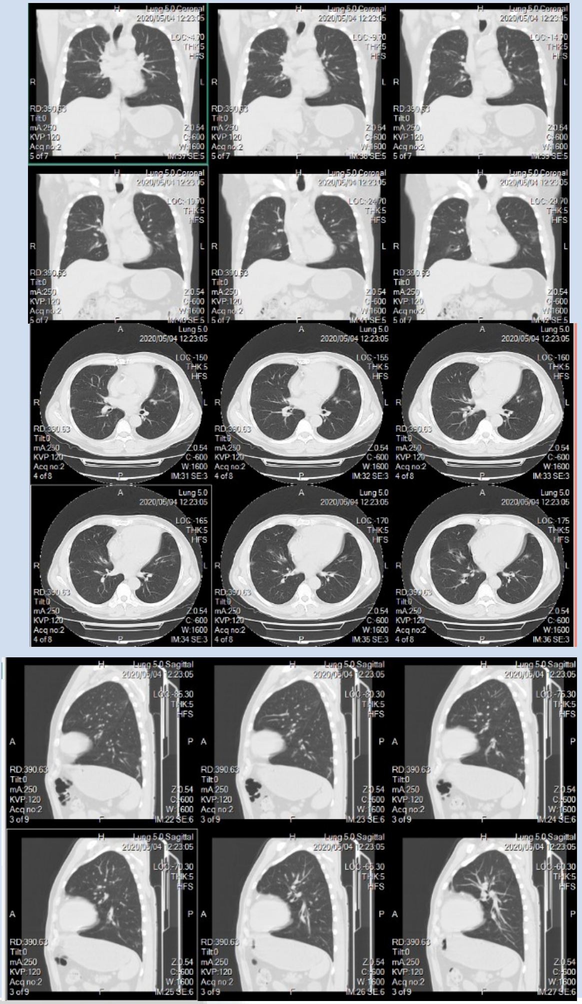
## CT at 29/4



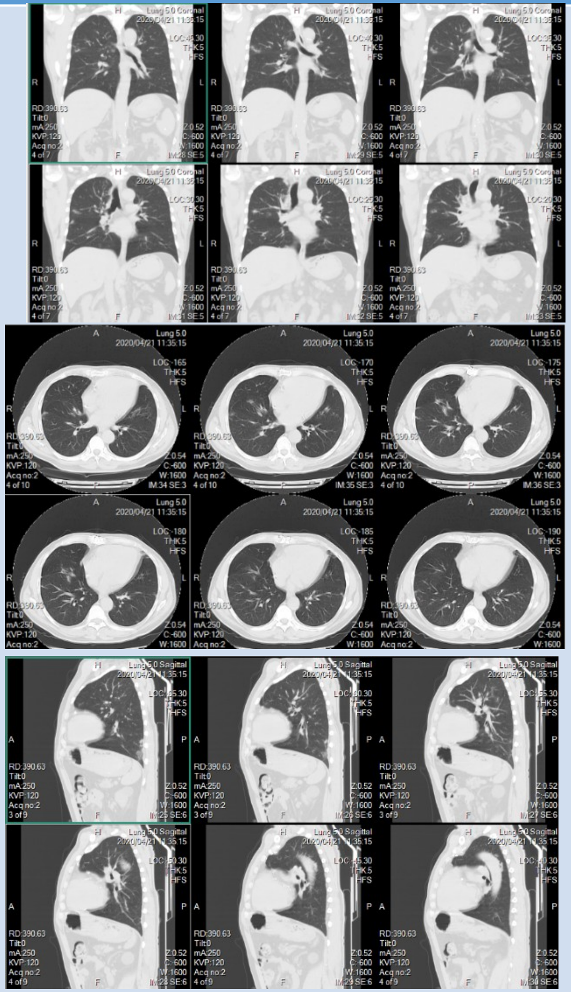
years old male was admitted to hospital on16/4 with (positive PCR), mild dyspnea started 68
.medications from 16/4 to 1/5 (negative PCR test) with rapid clinical improvement within days

Bilateral patchy veiling (GGO) and consolidation is seen namely peripheral L.L, median sternotomy
.....is seen (classic covid19, CORADS 6)

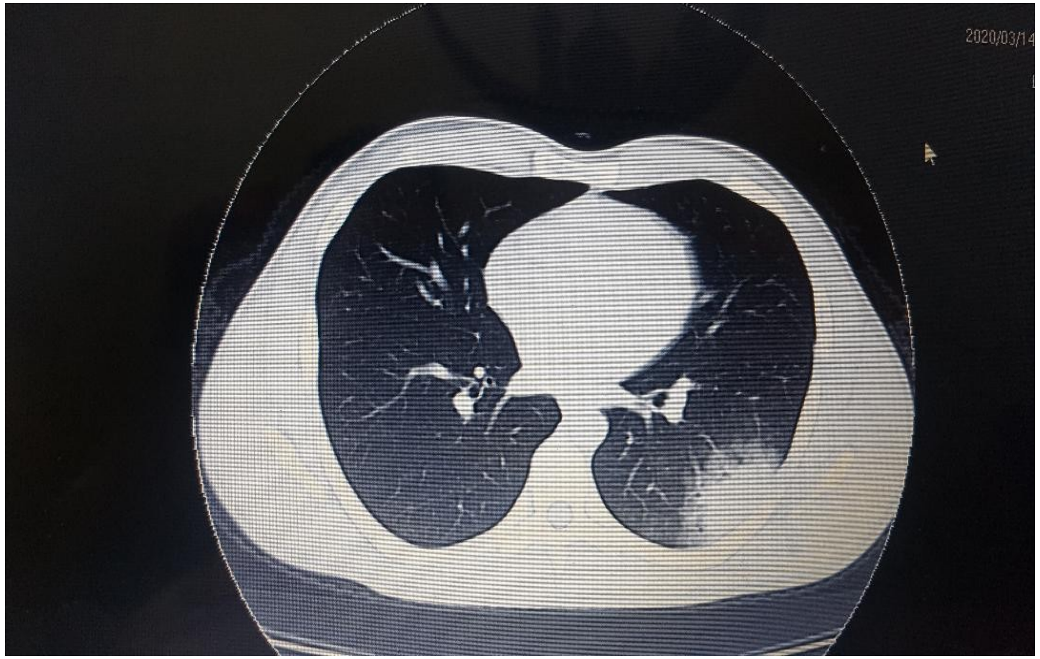
## CT at 16/4

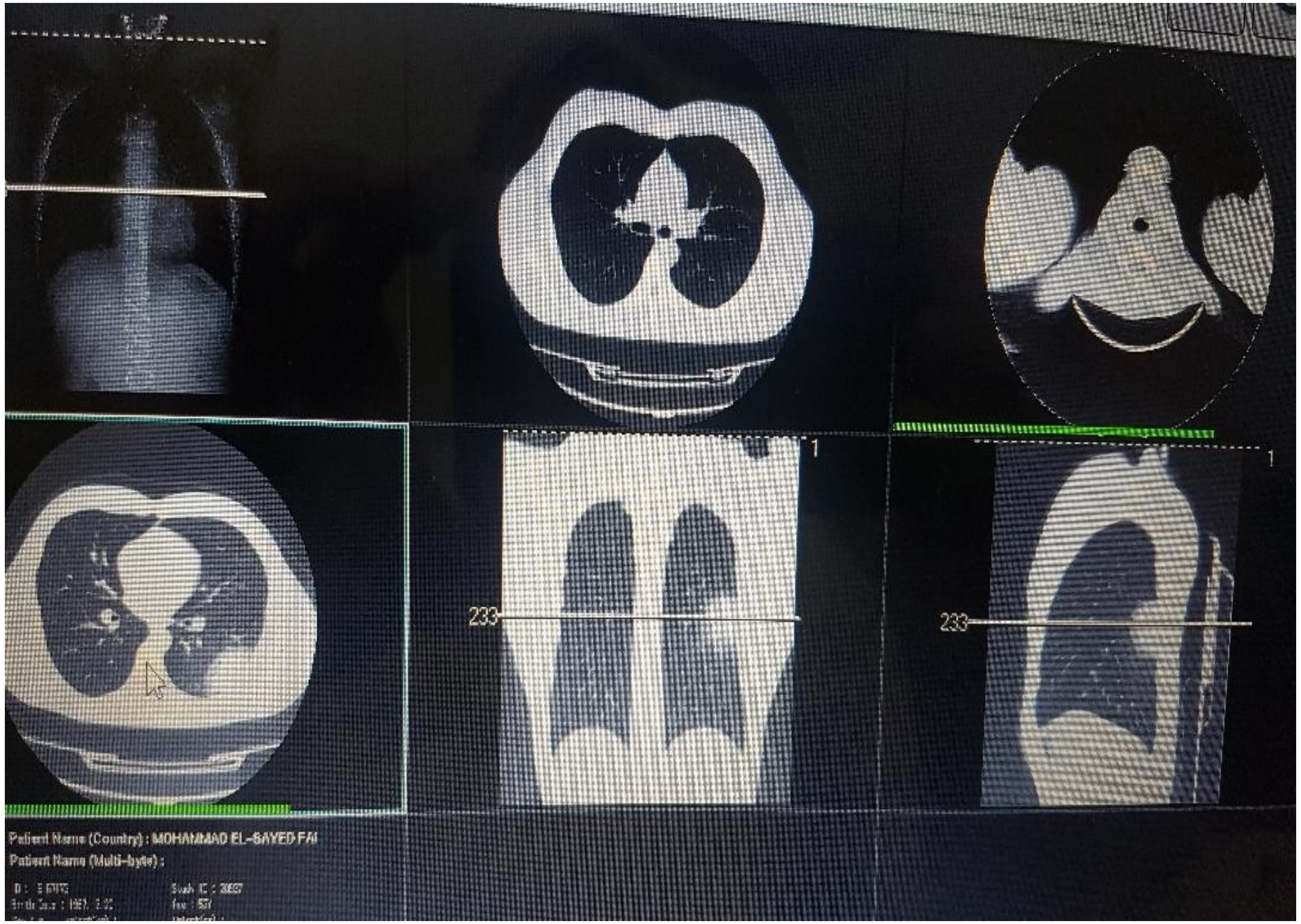


## CT at 21/4



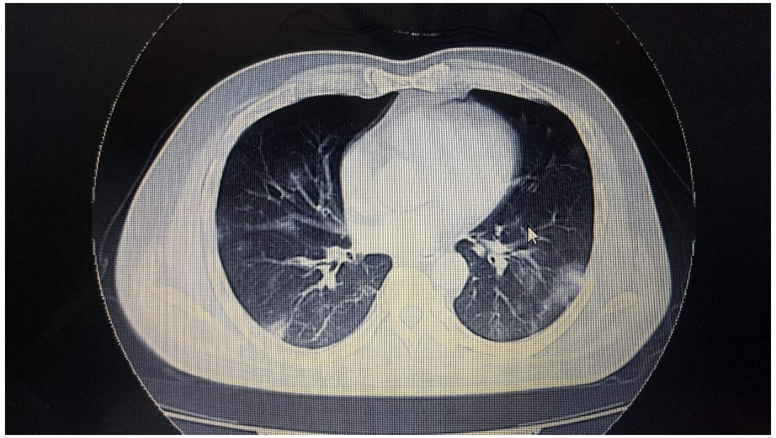
a 49 years old male patient presented by fever, dyspnea, and sore throat
14/3 patch of consolidation is seen at left l.l posteriorly and peripherally surrounded by veiling

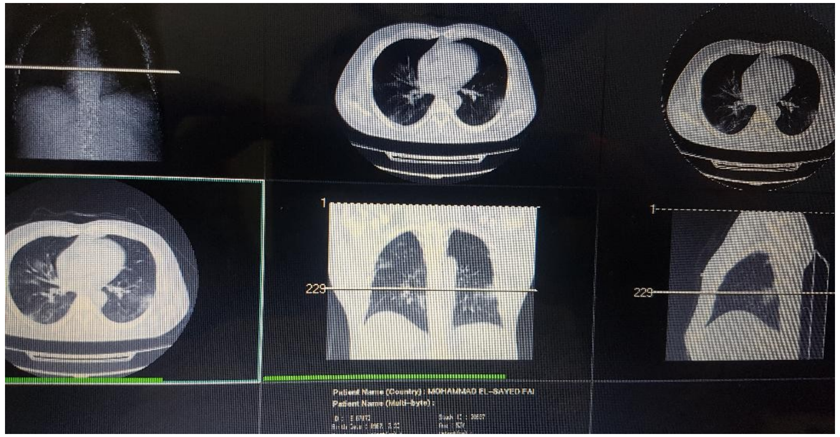




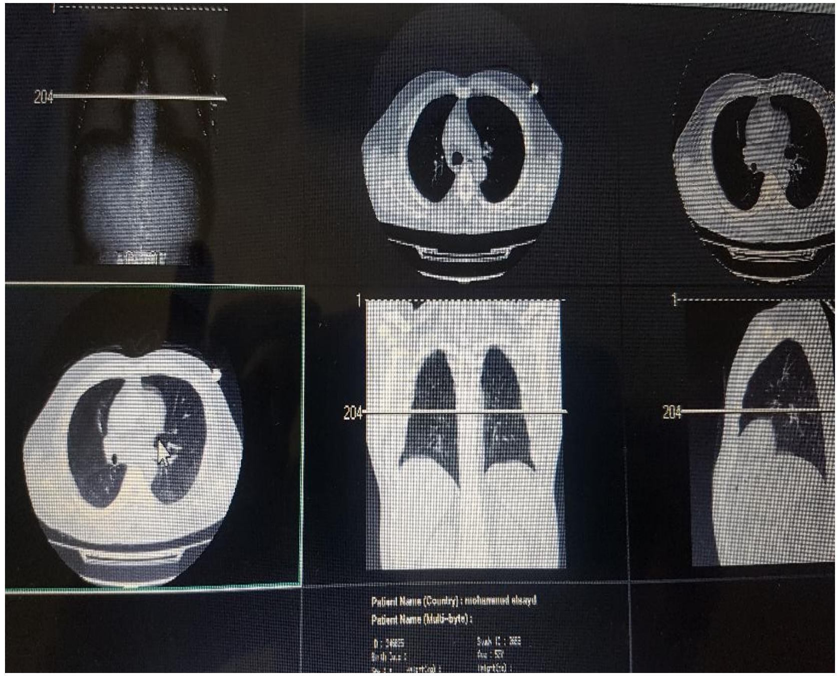
Patient Name (Country) : MOHAMMAD EL-SAYED FAI
Patient Name (Multi-byte) :

# 15/3 sudden appearance of bilateral ill defined patch veiling with reduced density of the solitary patch of consolidation



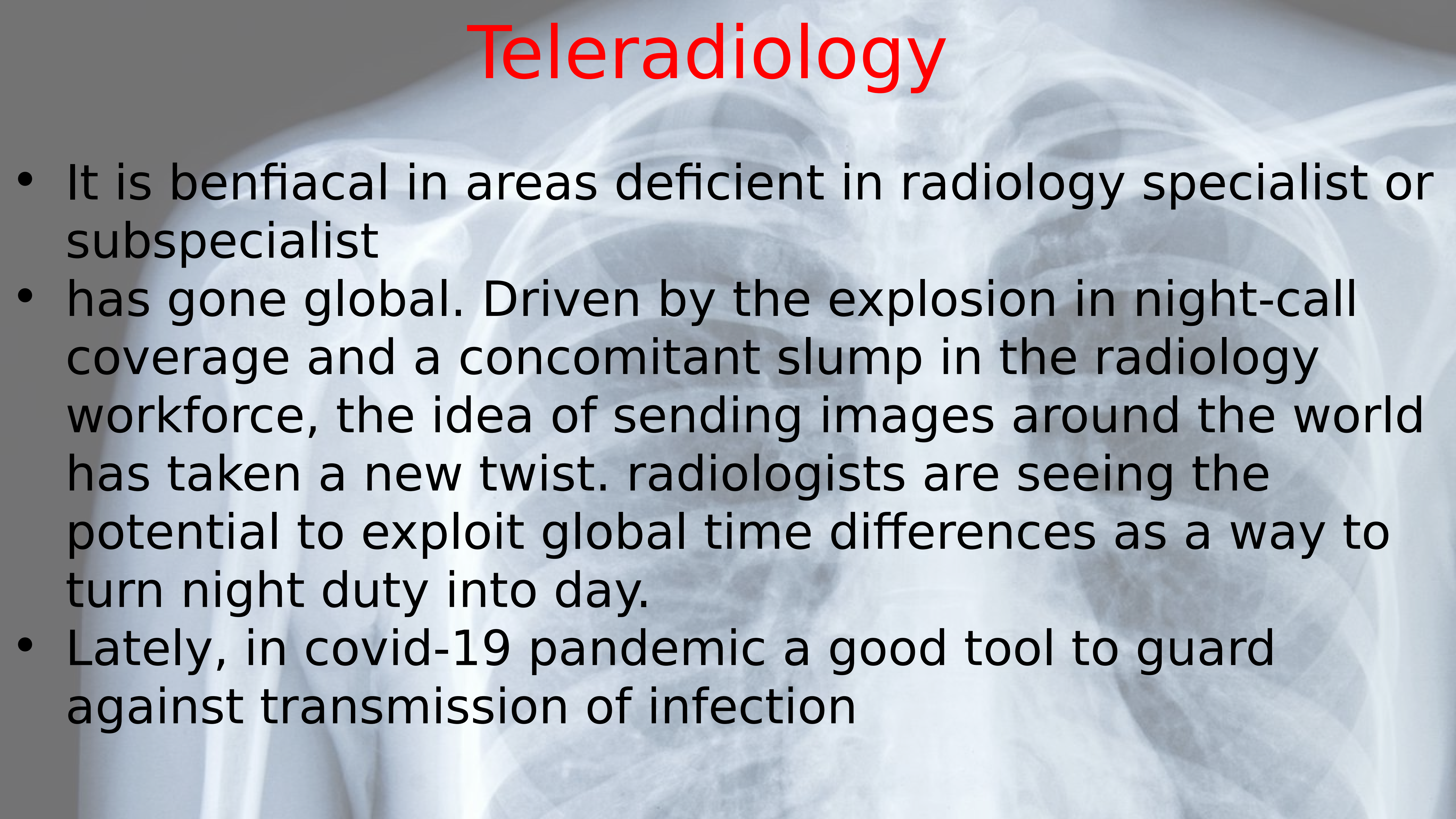

1
229
1
229
Patient Name (Country) : MOHAMMAD EL-SAYED FA
Patient Name (Multi-byte) :

Almost resolution of patchy veiling, negative PCR on 28/3

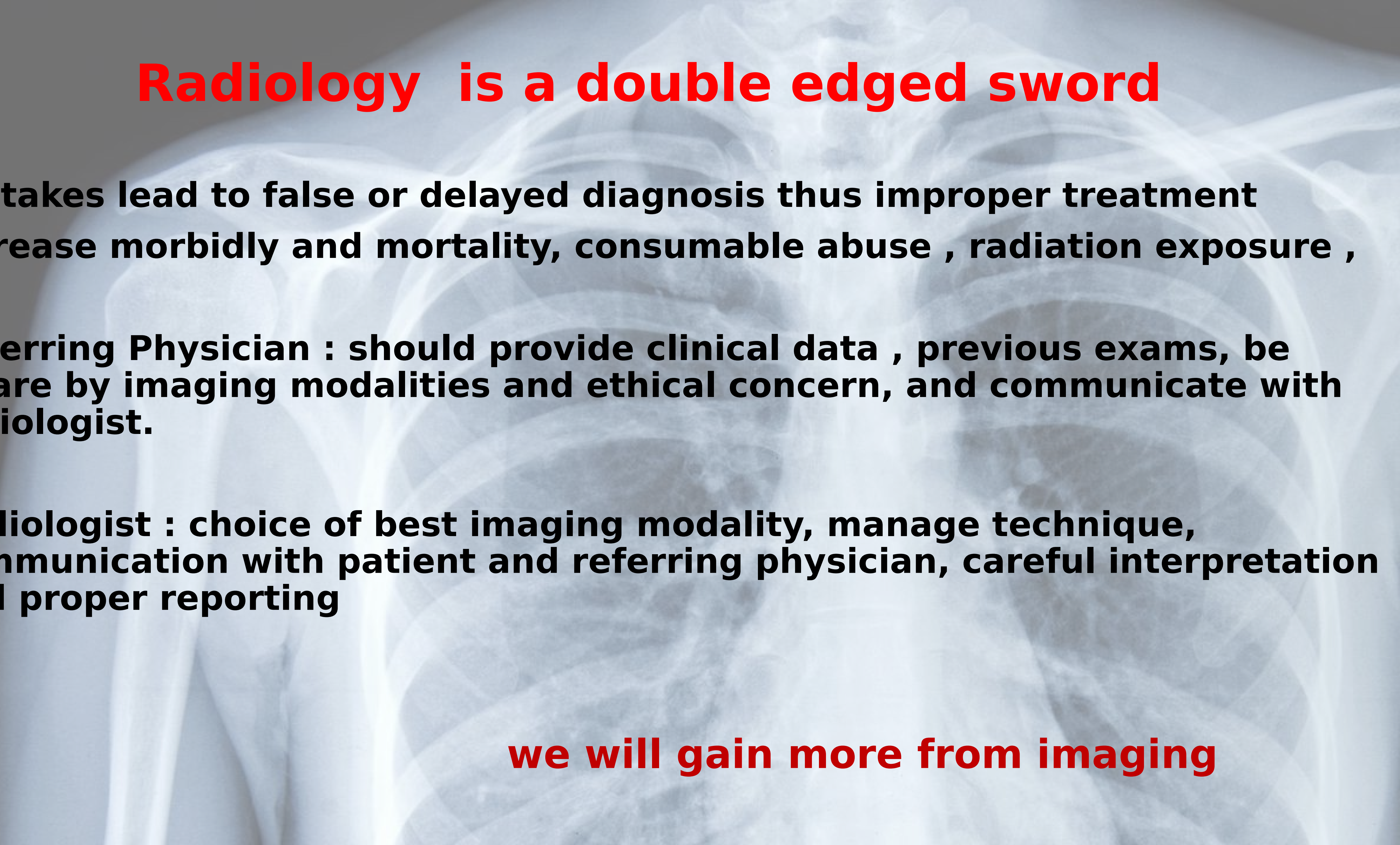

204
1
204
1
204
Patient Name (Country) : mohammed elsayd
Patient Name (Multi-byte) :

45 years old male was admitted to hospital on 14/4 with +ve PCR , fever a
bilateral scattered ground glass patches are seen namely lower lobar perip
posterior .some with central spared area ( reversed hallo sign) associated
strands impressive of pneumonia. Covid 19 is high suspected for clinical co
close follow up examination

# Teleradiology



- It is benfiacal in areas deficient in radiology specialist or subspecialist
- has gone global. Driven by the explosion in night-call coverage and a concomitant slump in the radiology workforce, the idea of sending images around the world has taken a new twist. radiologists are seeing the potential to exploit global time differences as a way to turn night duty into day.
- Lately, in covid-19 pandemic a good tool to guard against transmission of infection



# Radiology is a double edged sword

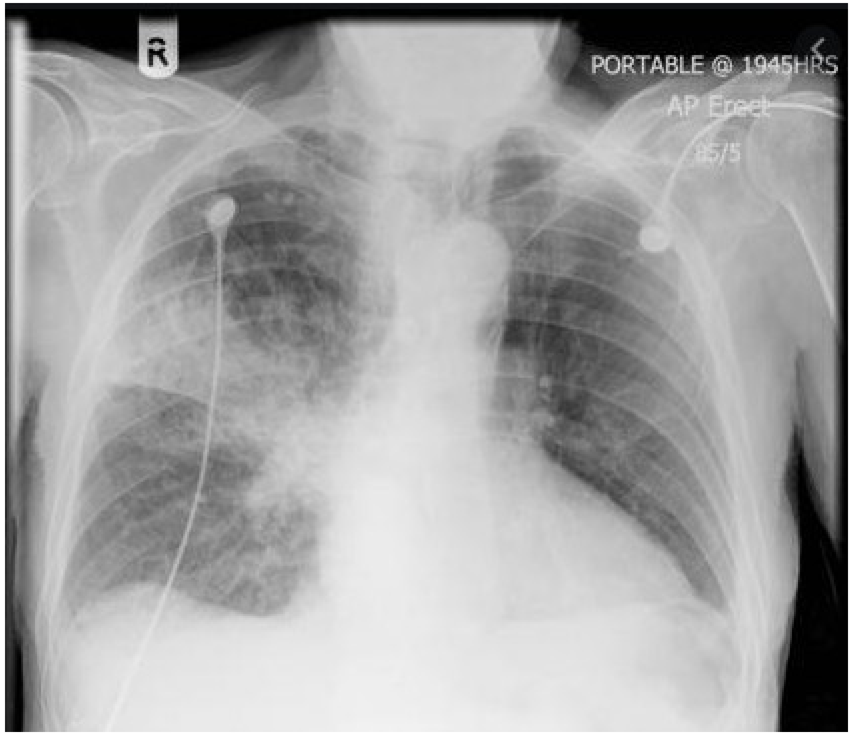
- **Mistakes lead to false or delayed diagnosis thus improper treatment**
- **increase morbidly and mortality, consumable abuse , radiation exposure ,**

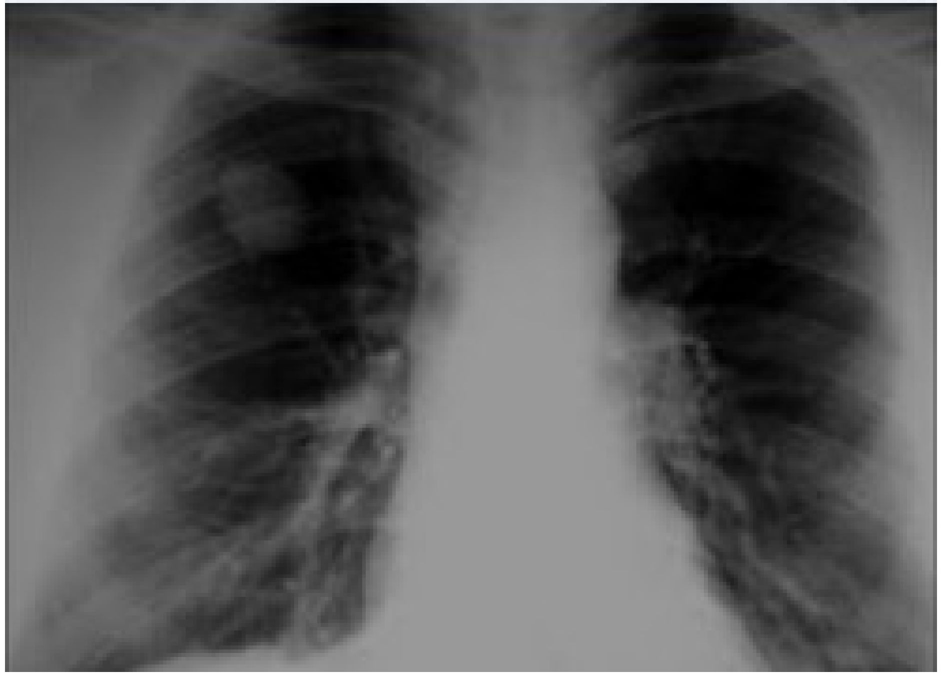
- **Referring Physician : should provide clinical data , previous exams, be aware by imaging modalities and ethical concern, and communicate with radiologist.**

- **Radiologist : choice of best imaging modality, manage technique, communication with patient and referring physician, careful interpretation and proper reporting**

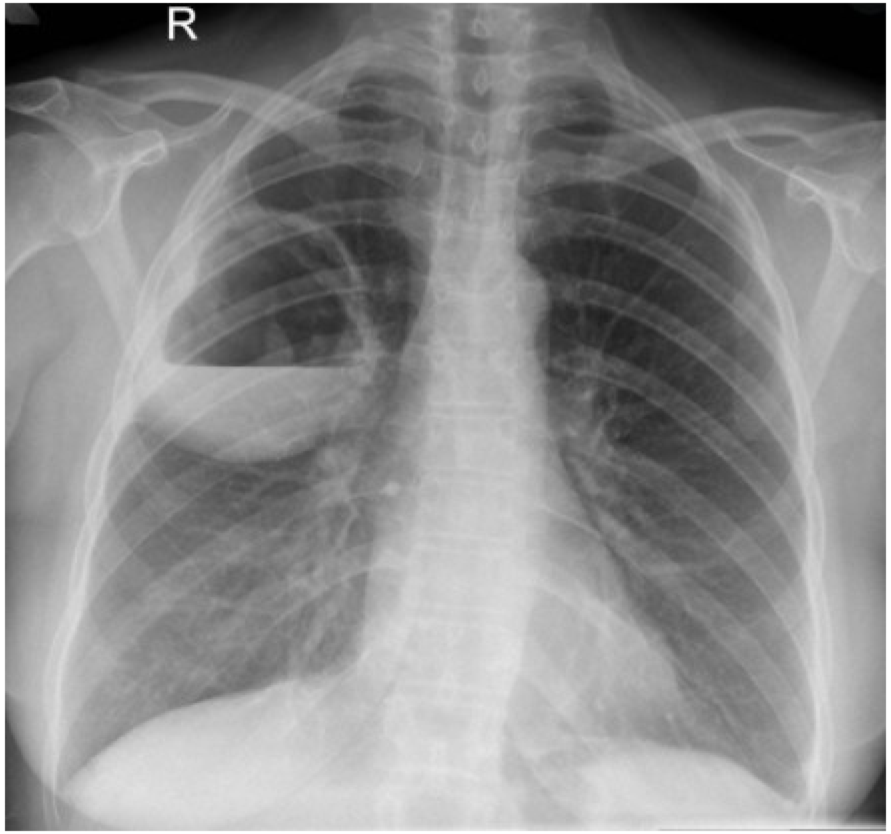
**we will gain more from imaging**

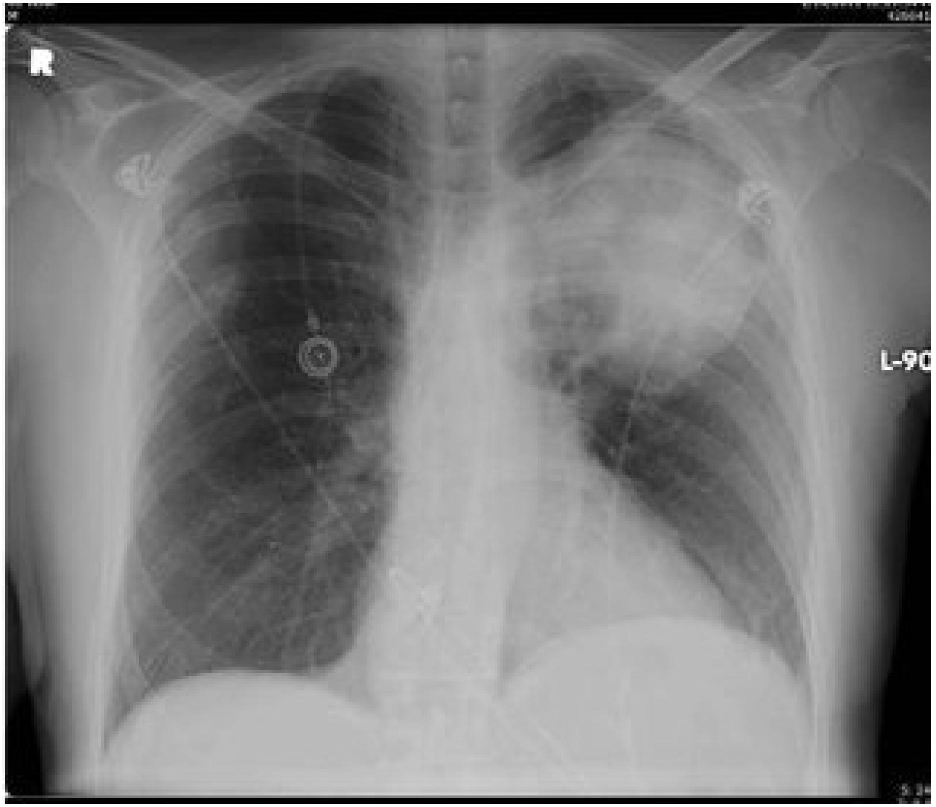
# Focal lung lesions



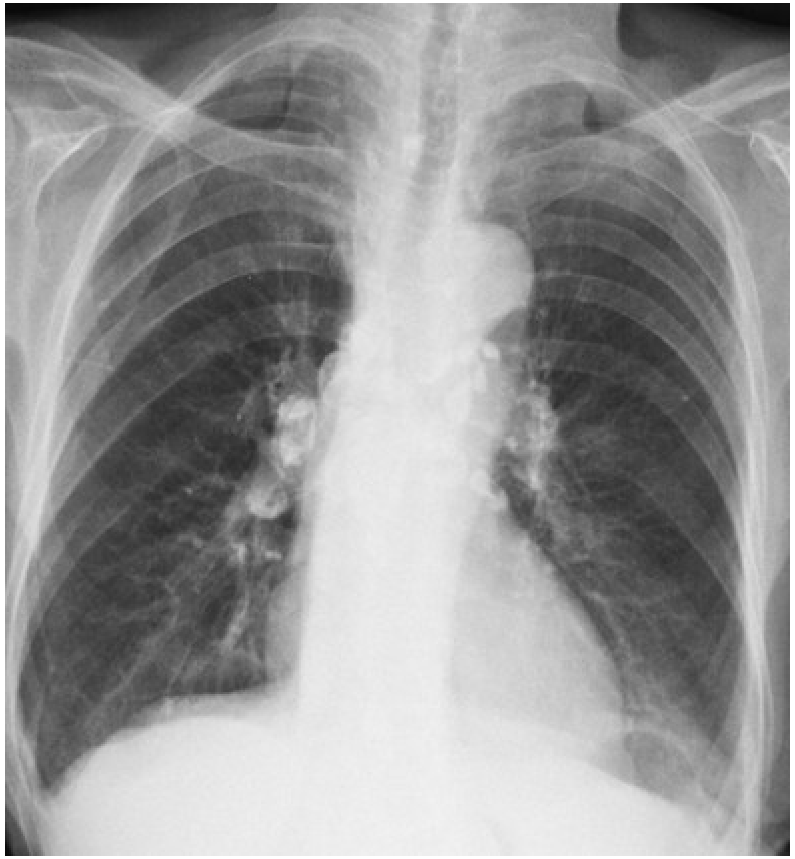
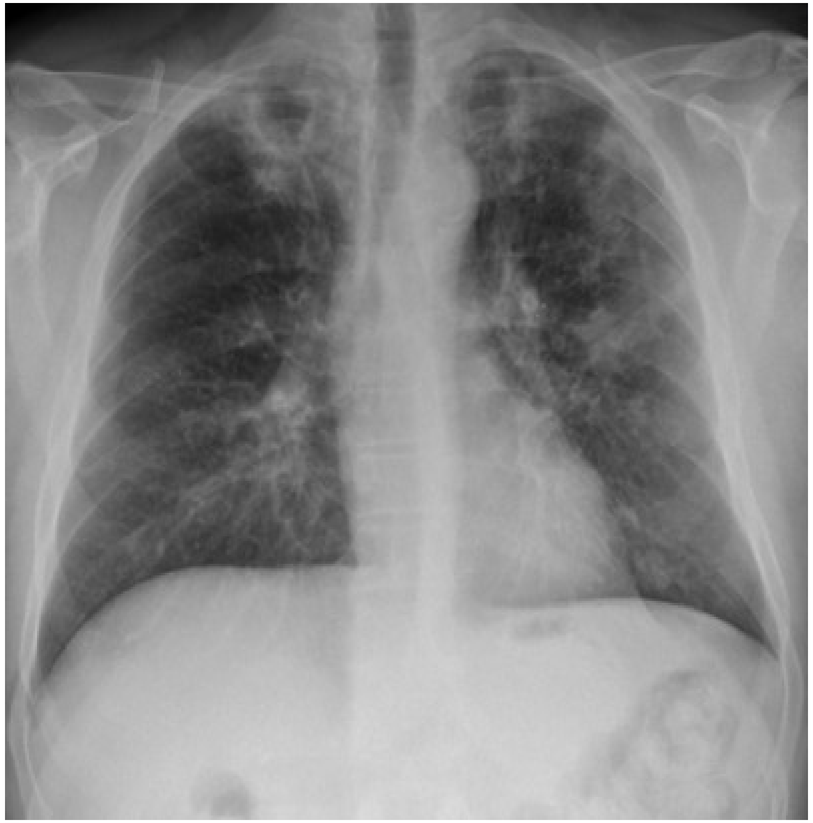


# Focal lung lesions

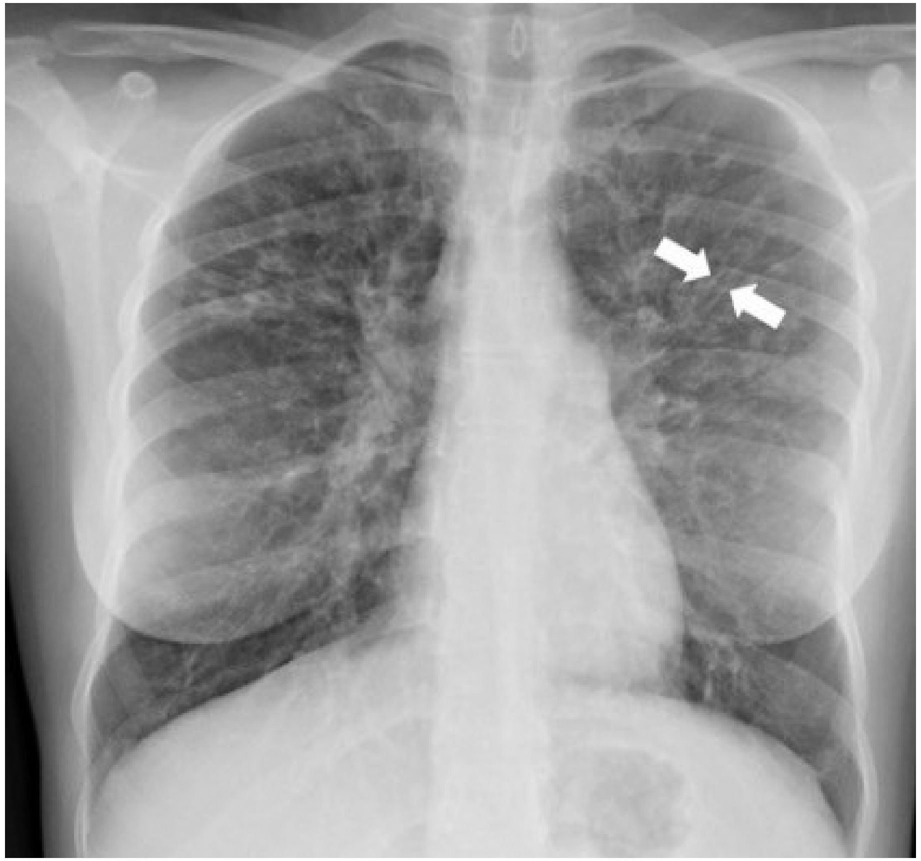




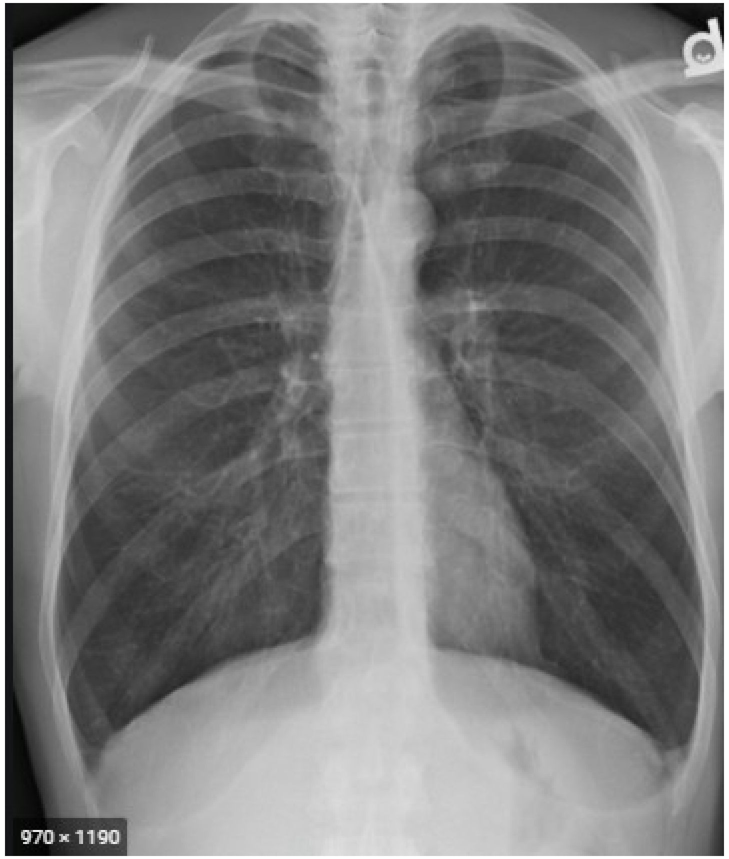
# Pulmonary T.B

| POST-PRIMARY TB | PRIMARY TB |
|---|---|
|  |  |

# Diffuse lung disease

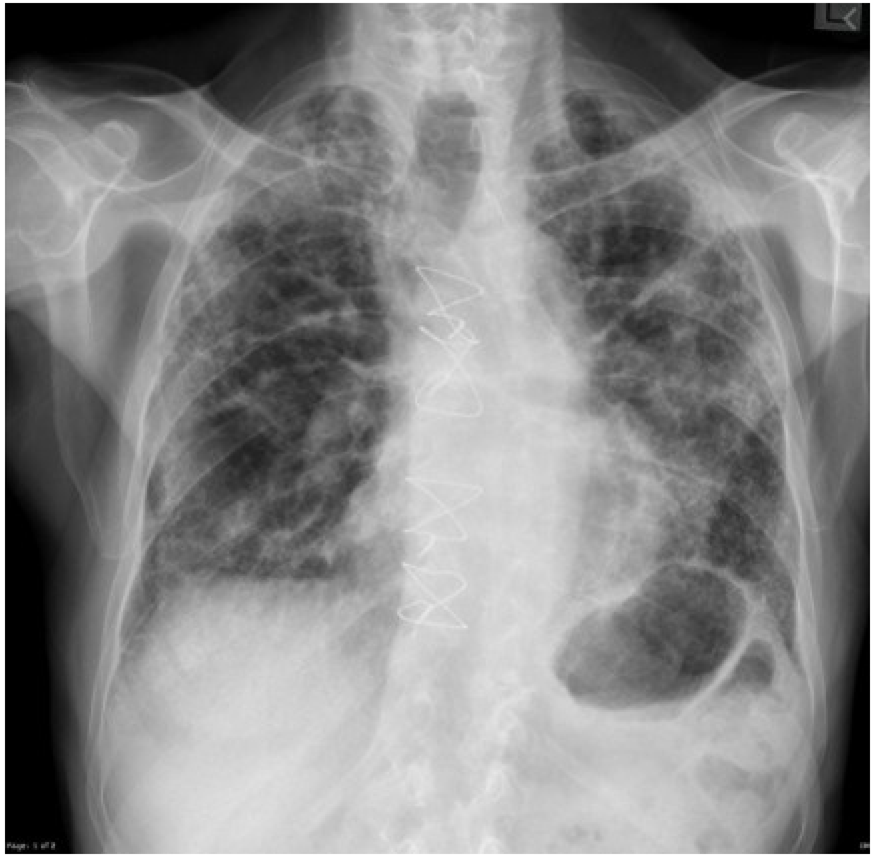


**BRONCHIATASIS**

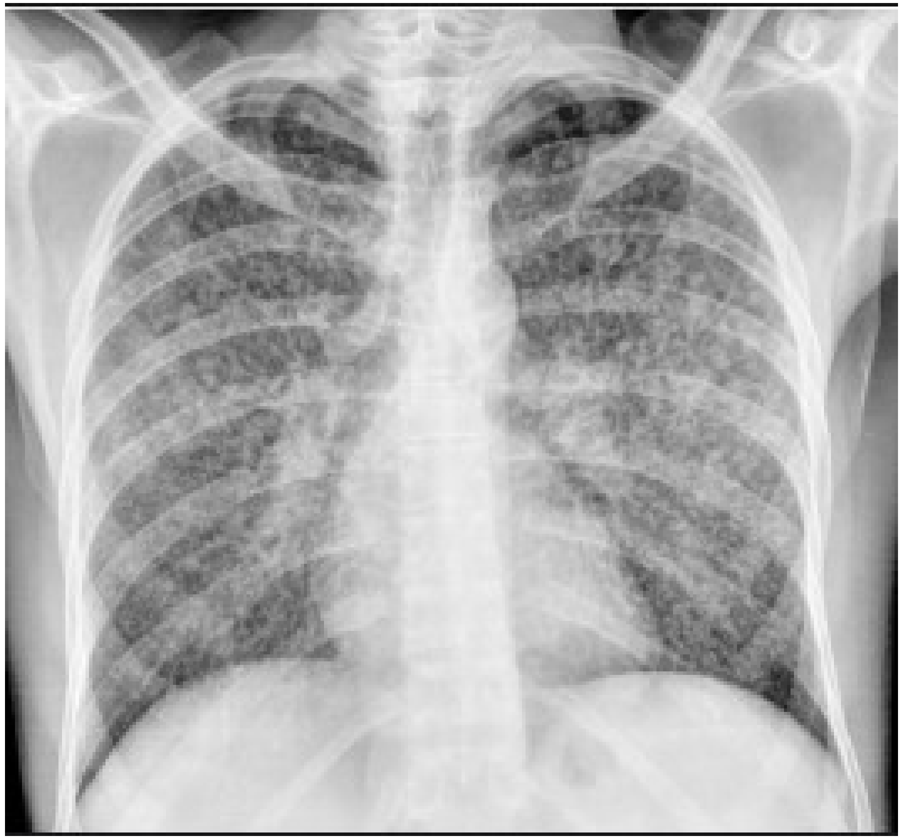


**EMPHYSEMA**

# Diffuse lung disease

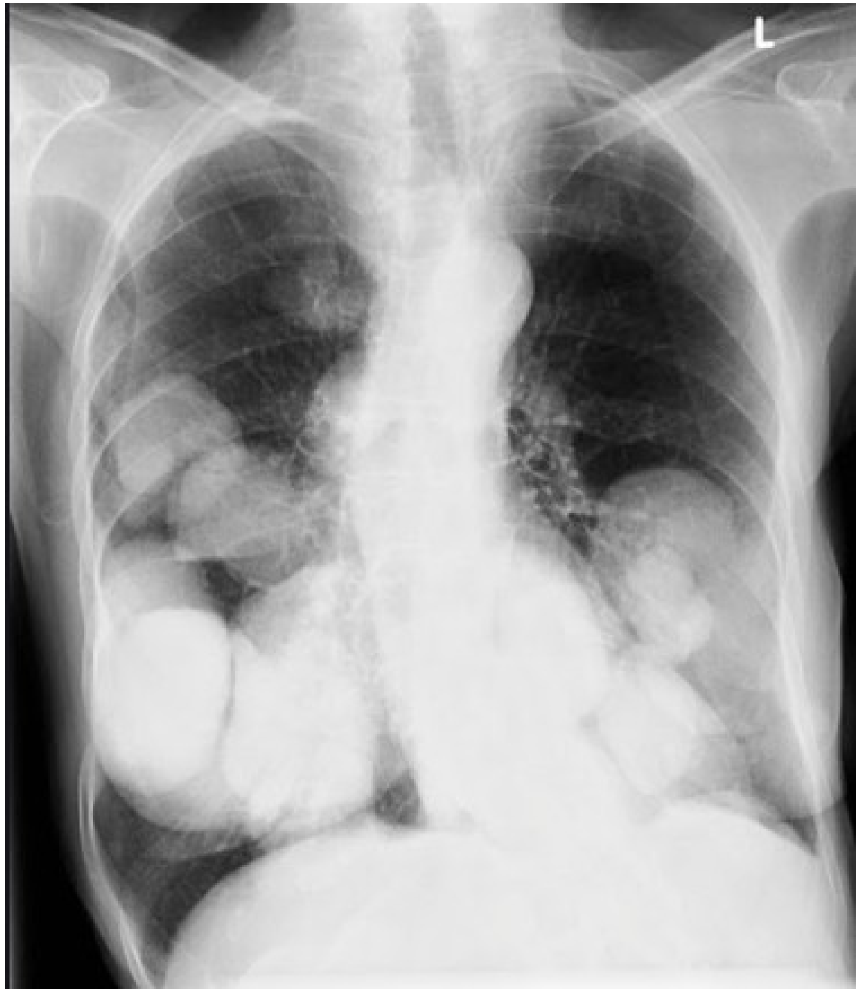


**Fibrosis**



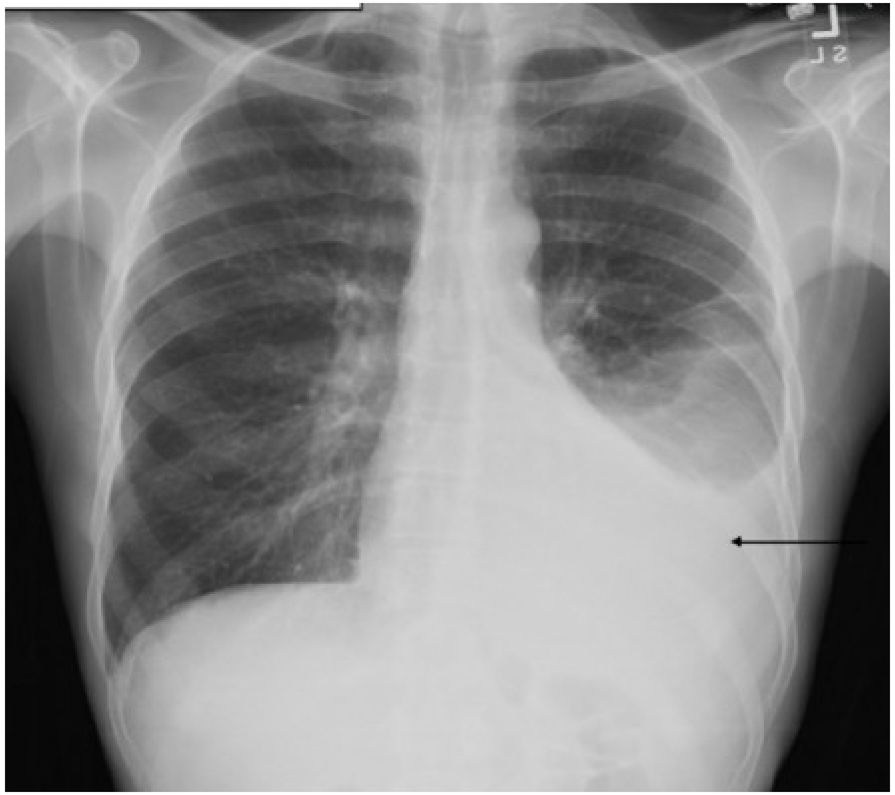
**Miliary T.B**

# Metastasis

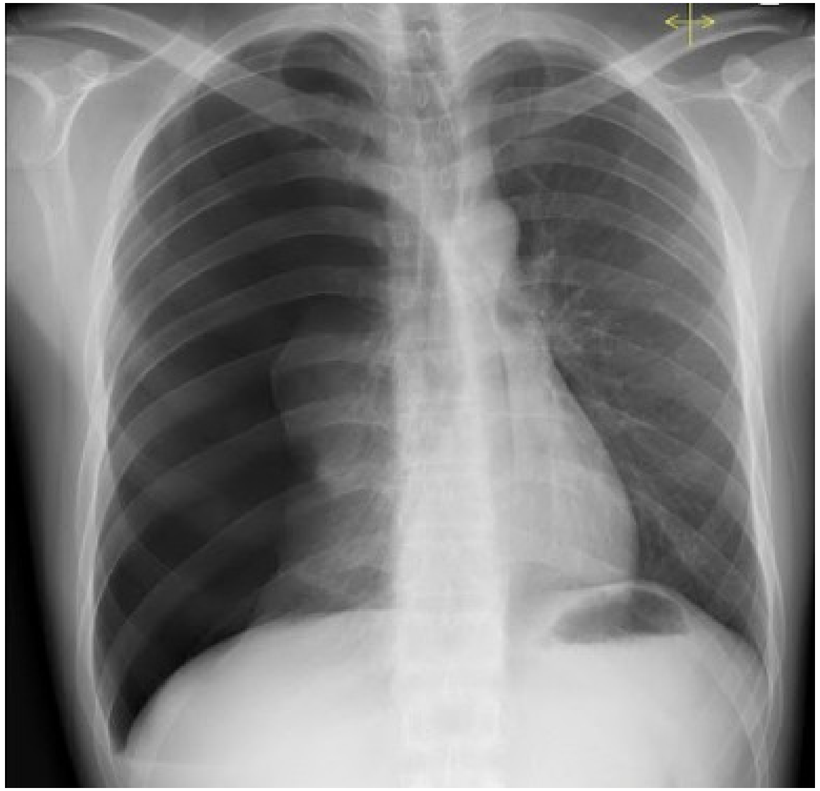


# Pleural lesions

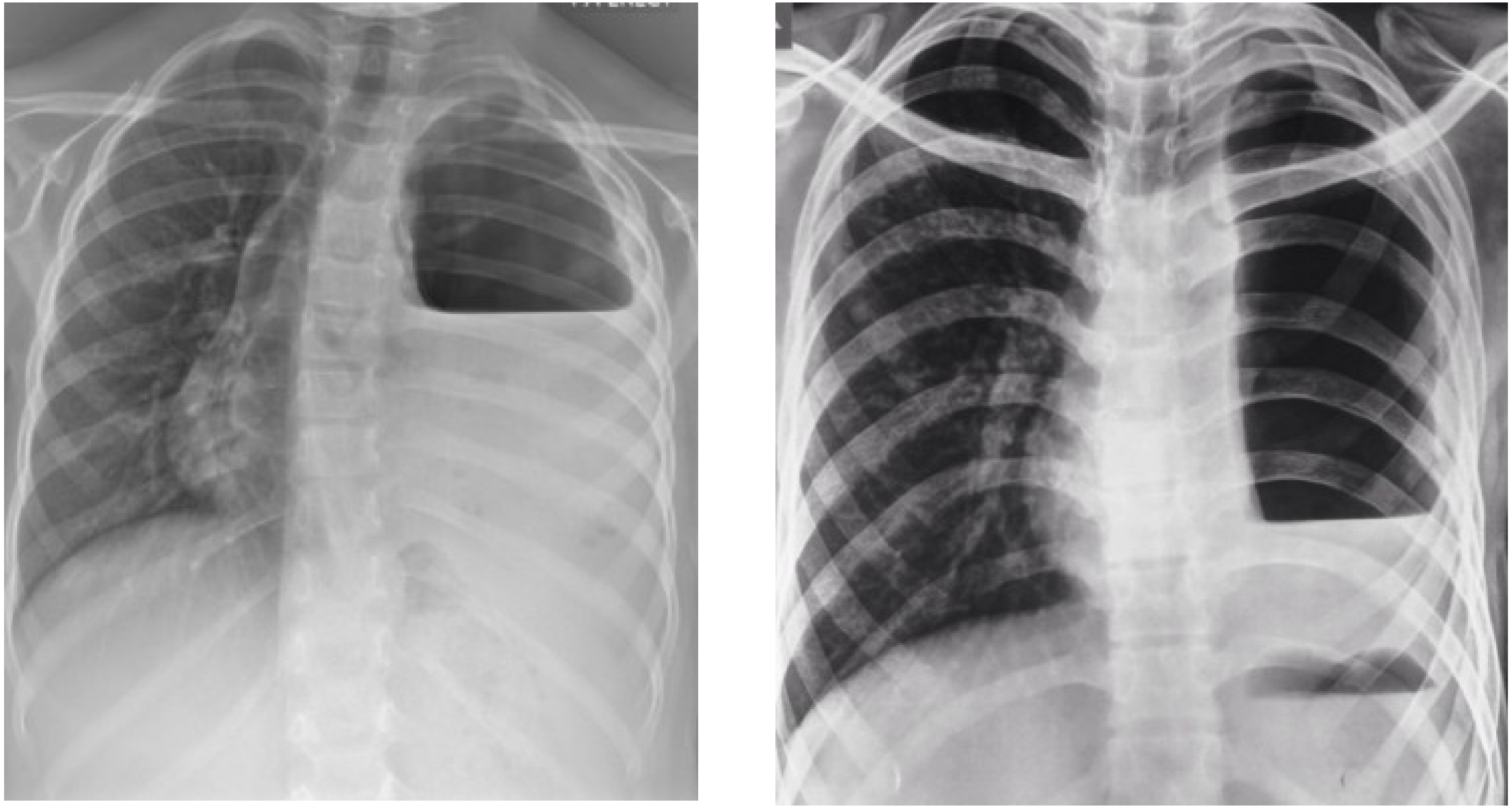
- Effusion



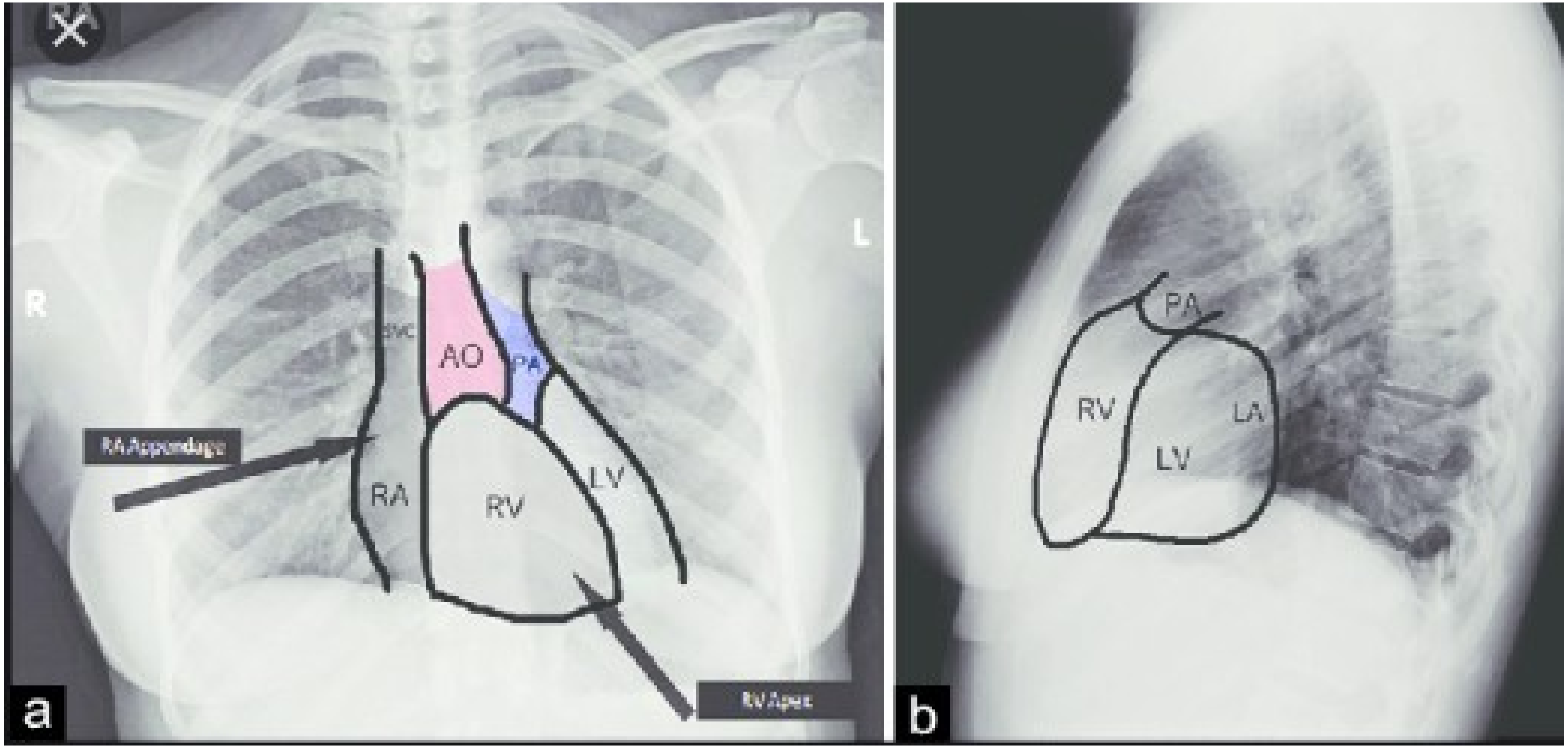
- Pneumothorax



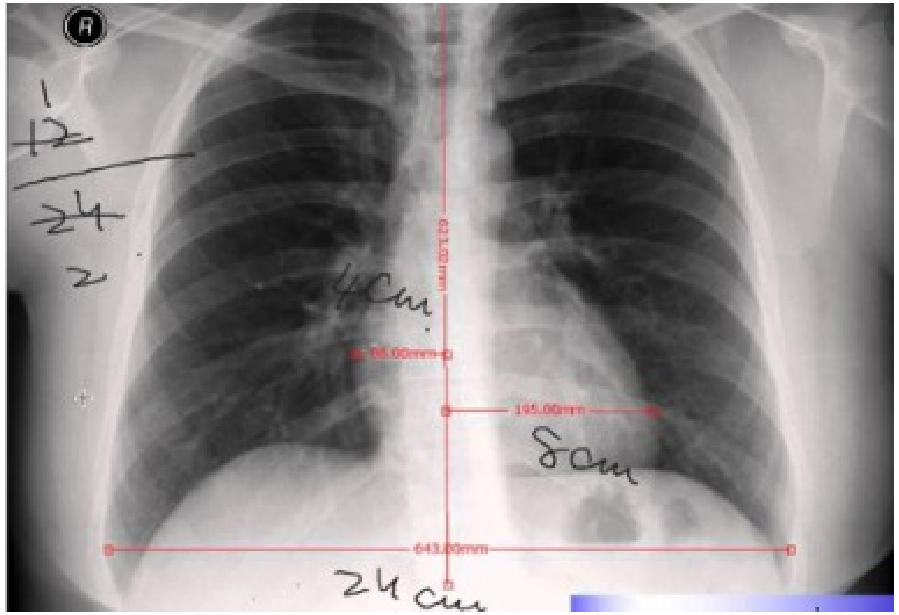
# Hydropneumothorax

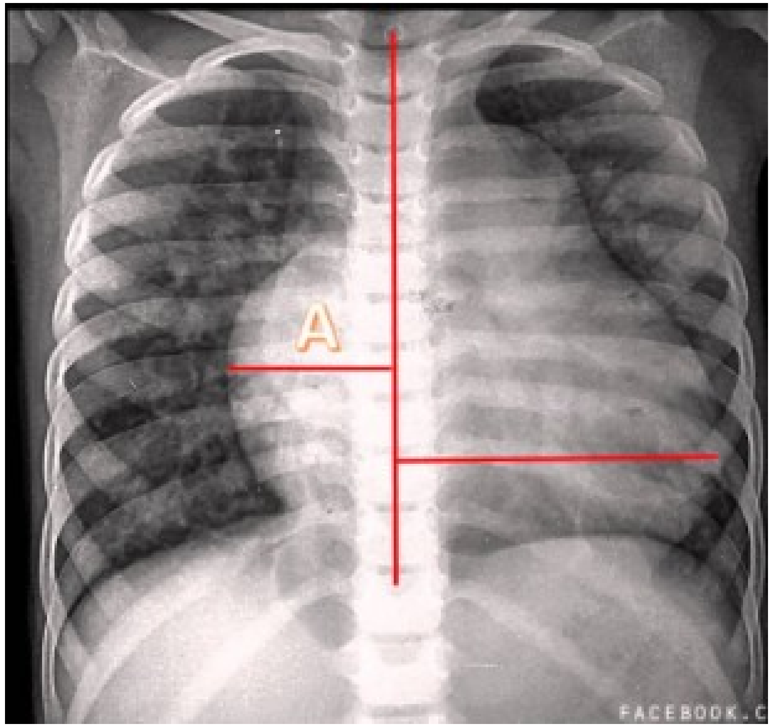


# Normal cardiac anatomy

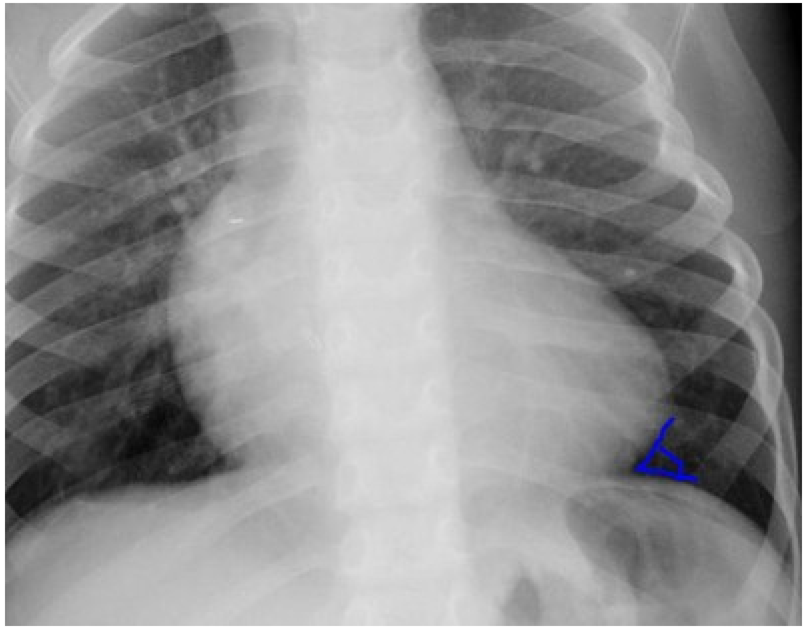


# Cadriomegaly



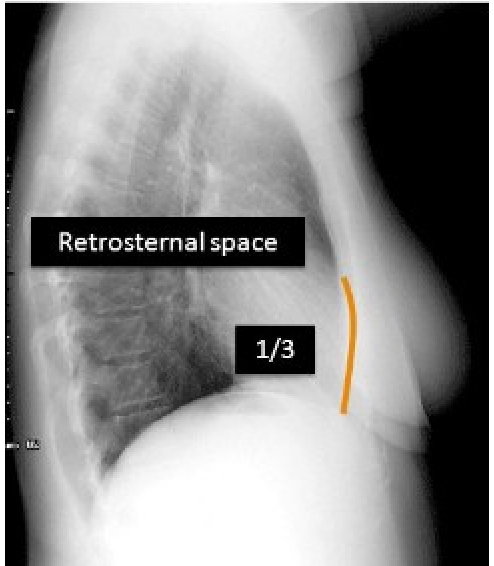


# Right ventricular enlargement

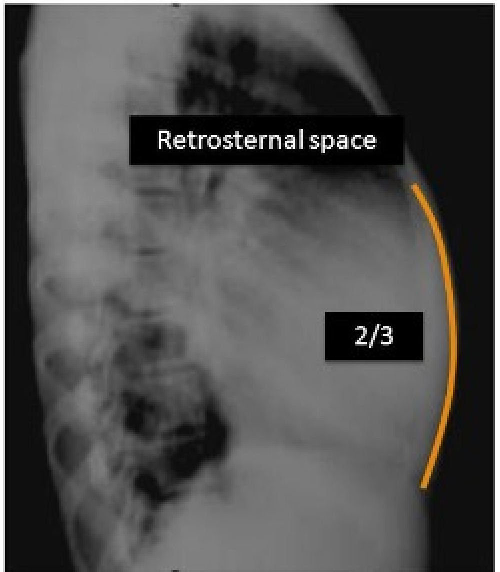


.Acute cardiac apex
.Obliterated retrosternal space

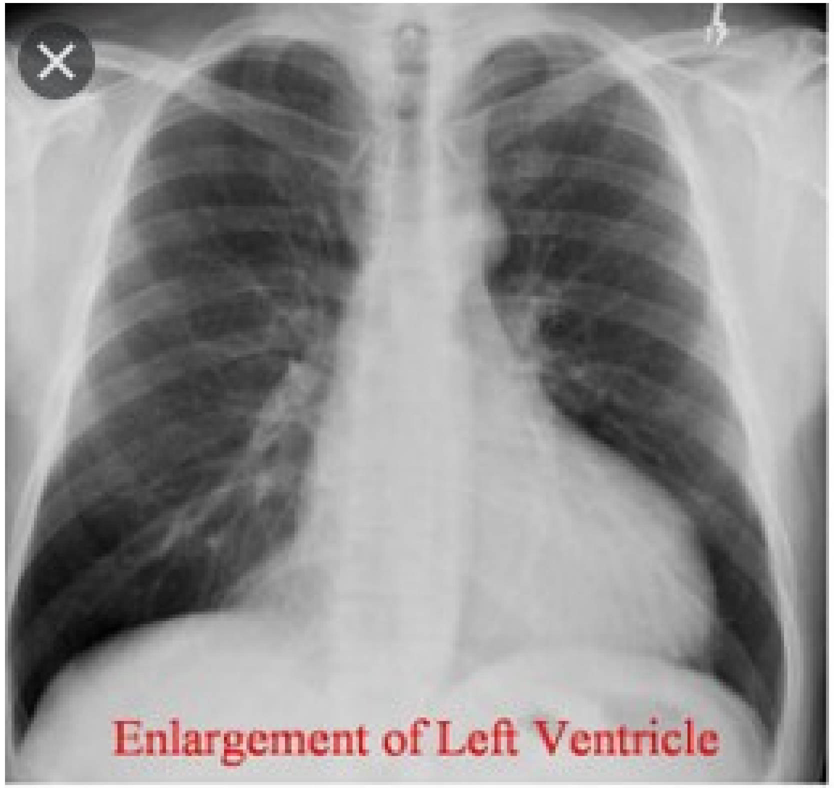
**Normal Lateral view**



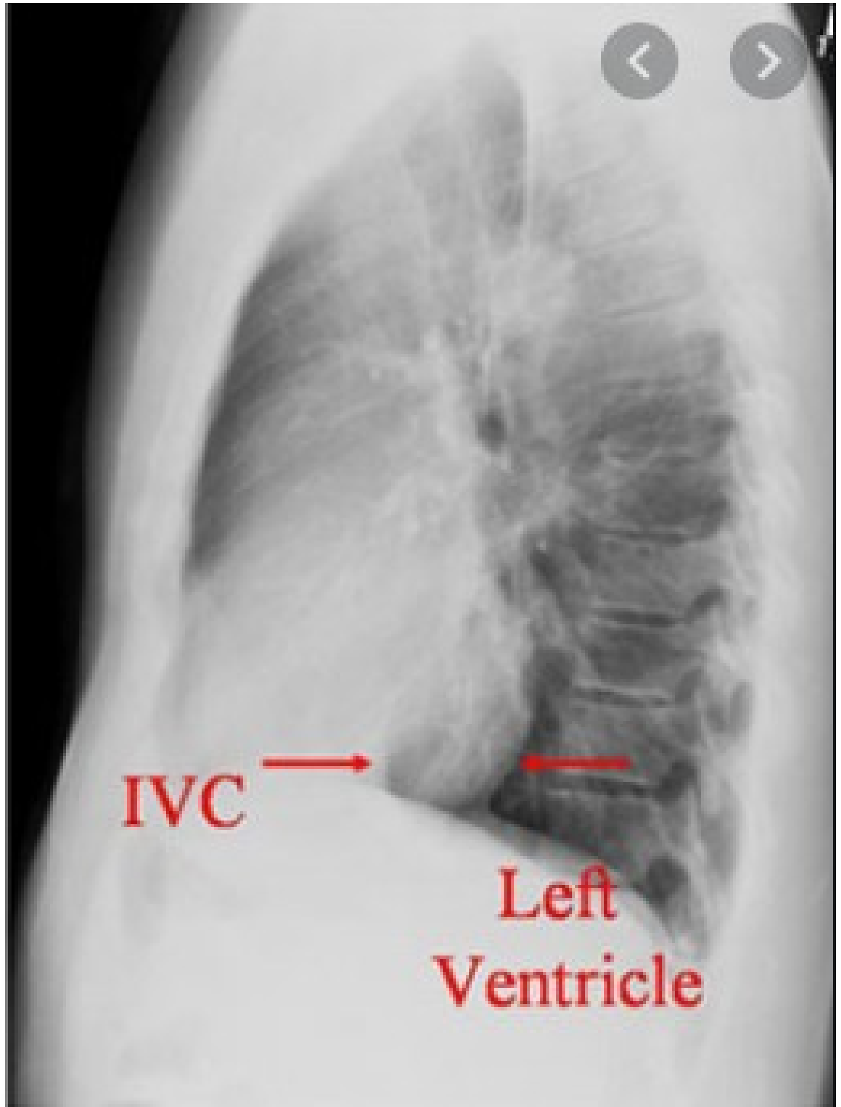
**Lateral view (ASD)**



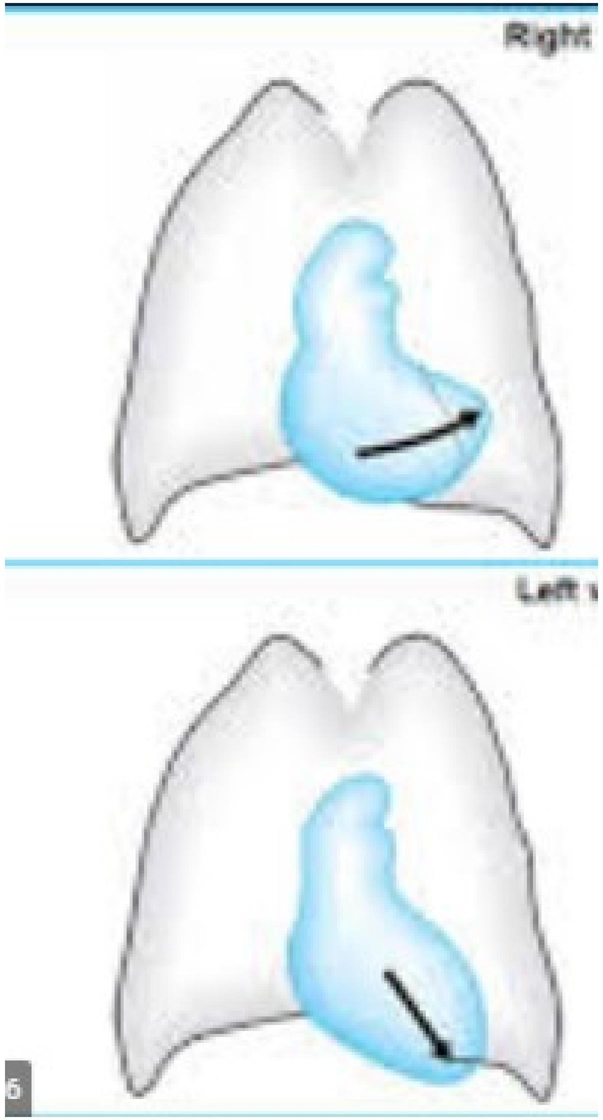
# Left ventricle enlargement

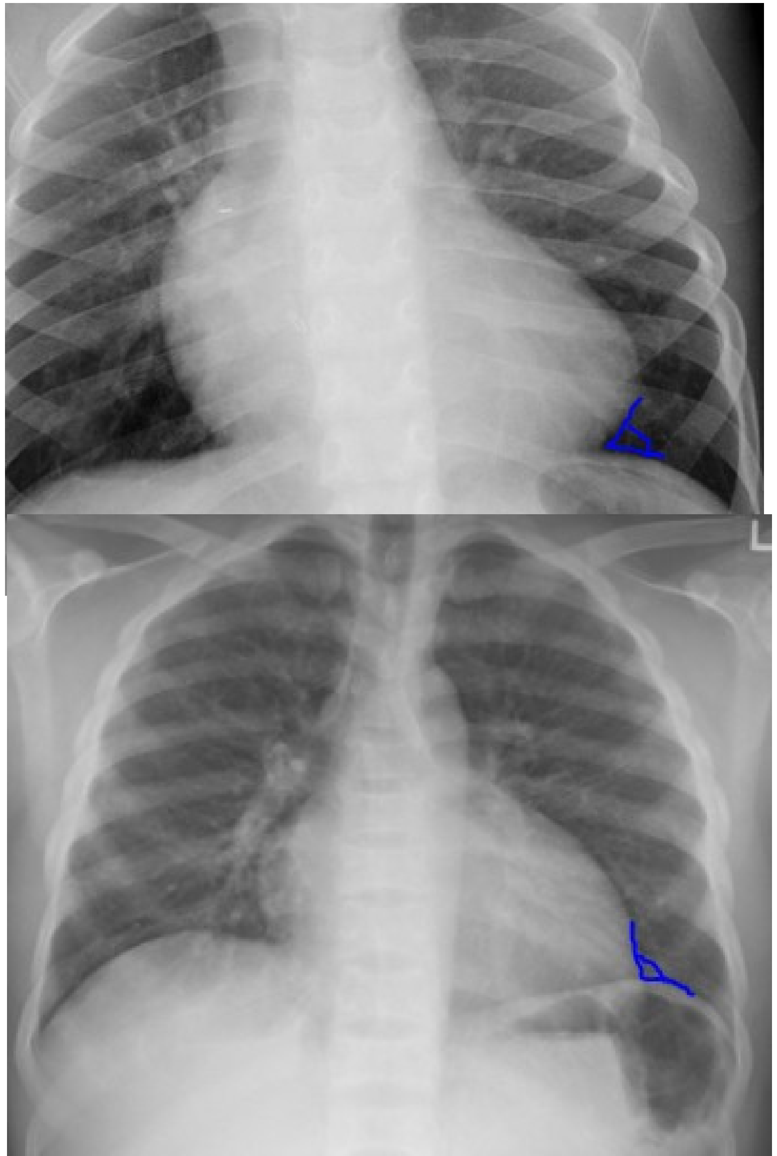


.Obtuse cardiac apex
Prominent lowerposterior border
.(lateral view)

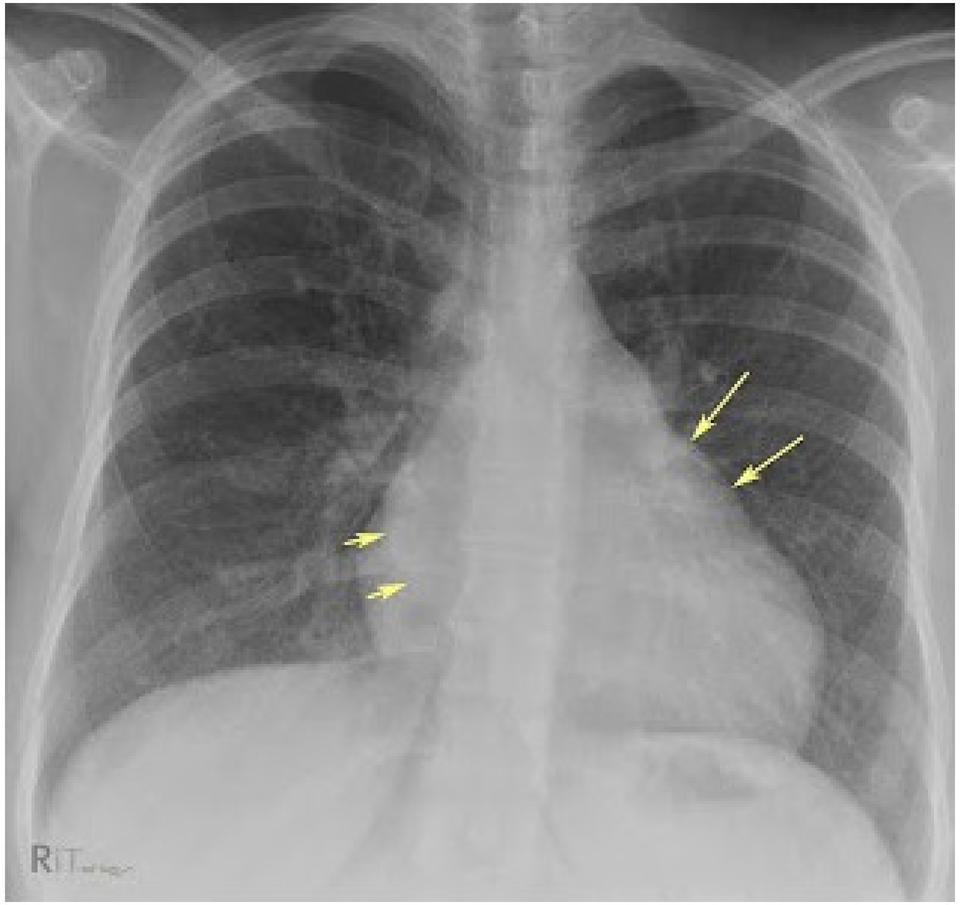


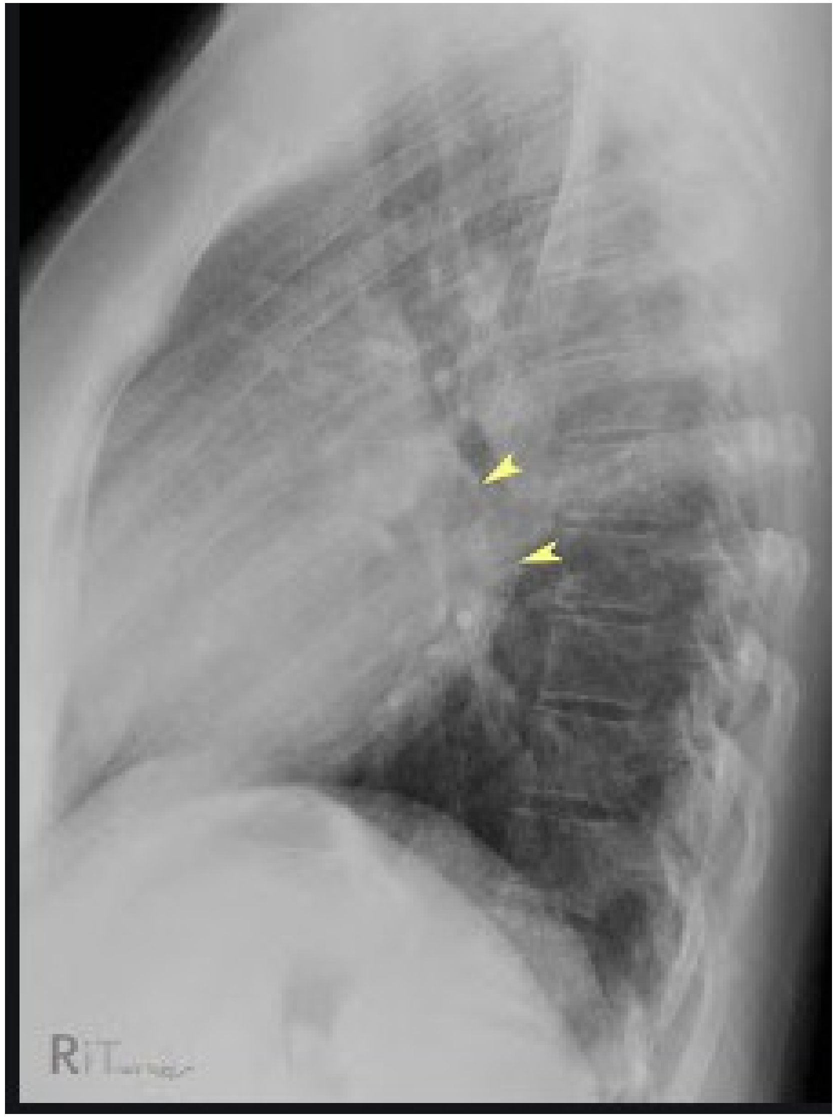
# Left versus right ventricular enlargement





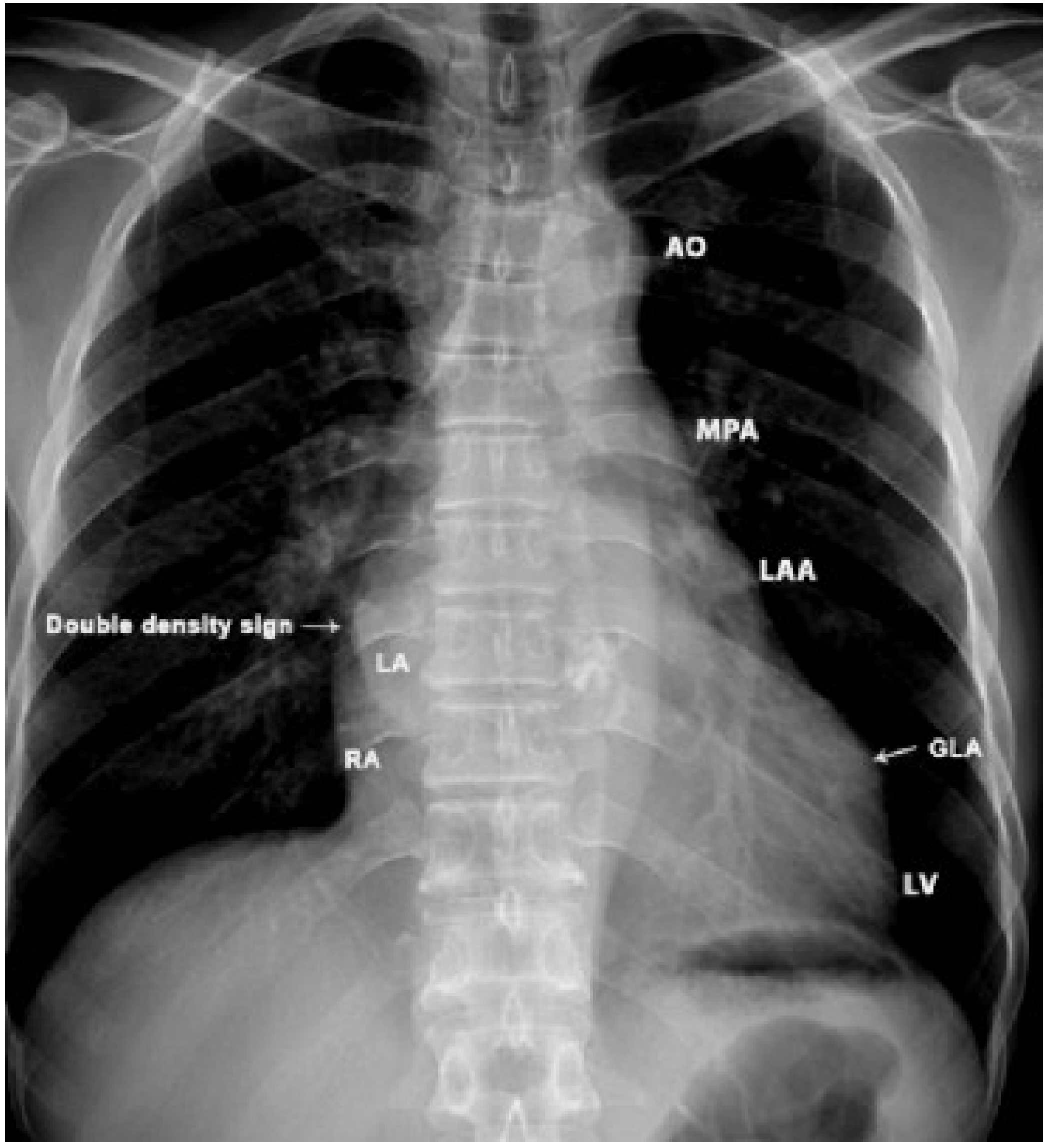
# Left atrial enlargement



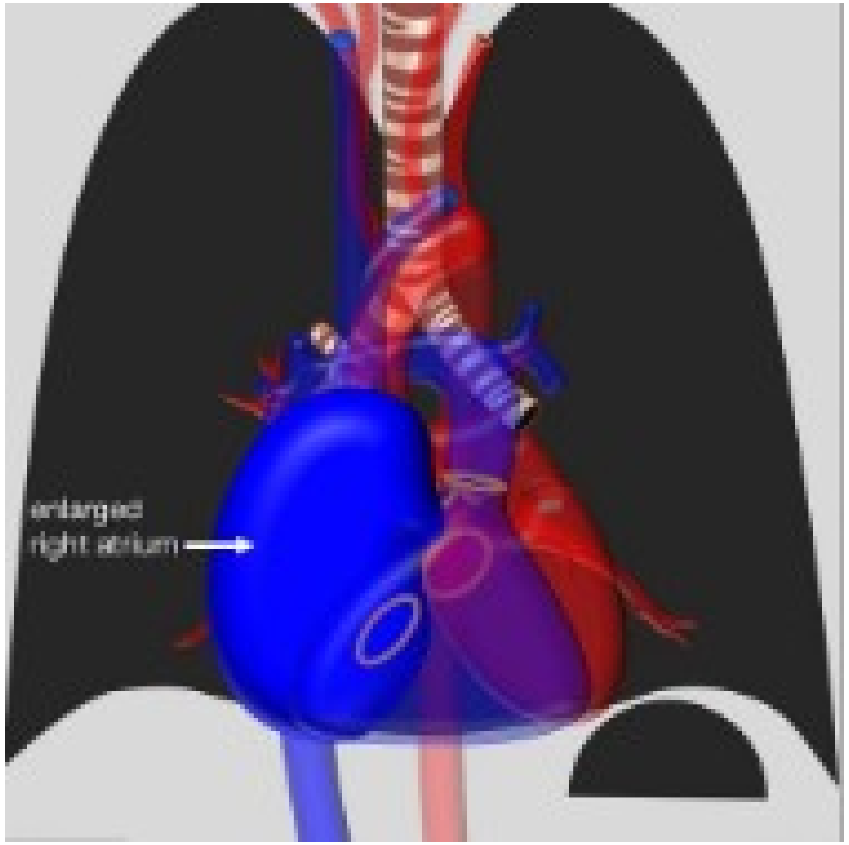


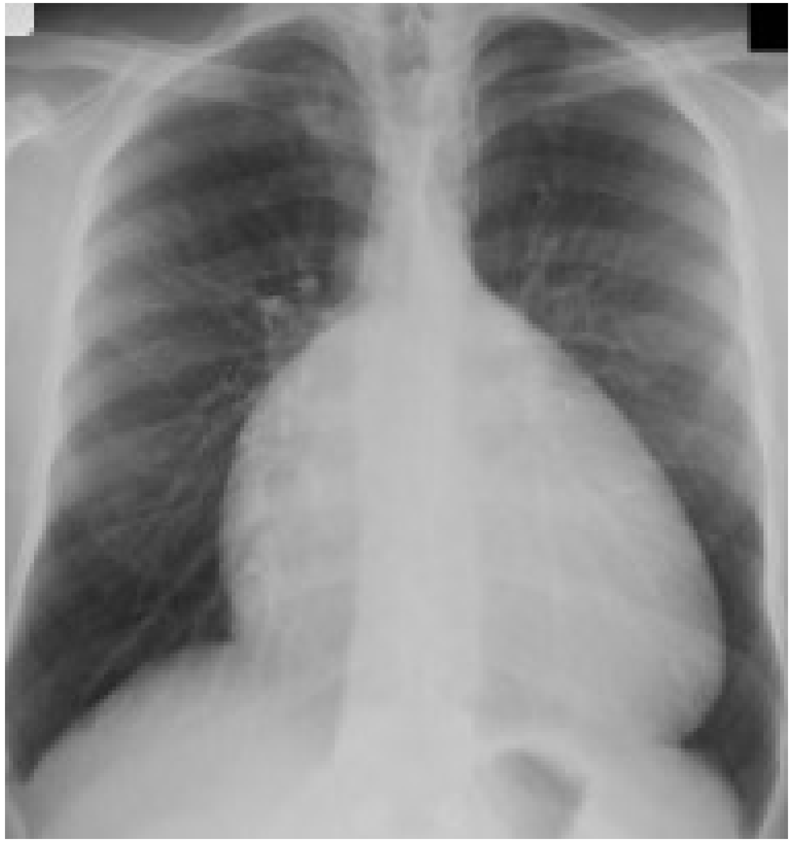
Right border double density
.Straightened left cardiac border
Prominent (convex) atrial
.appendage

# LA enlargement



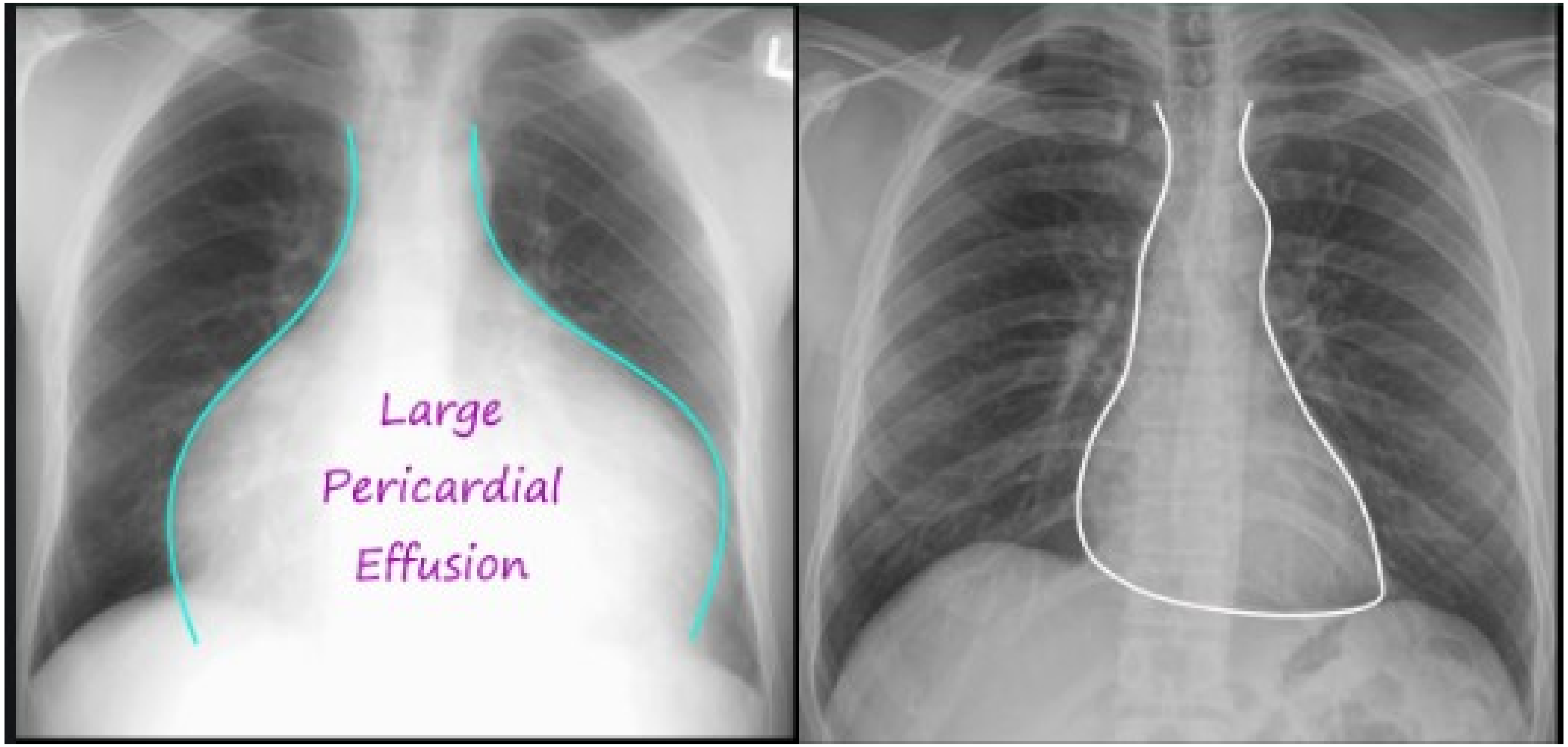
# Right atrial enlargement





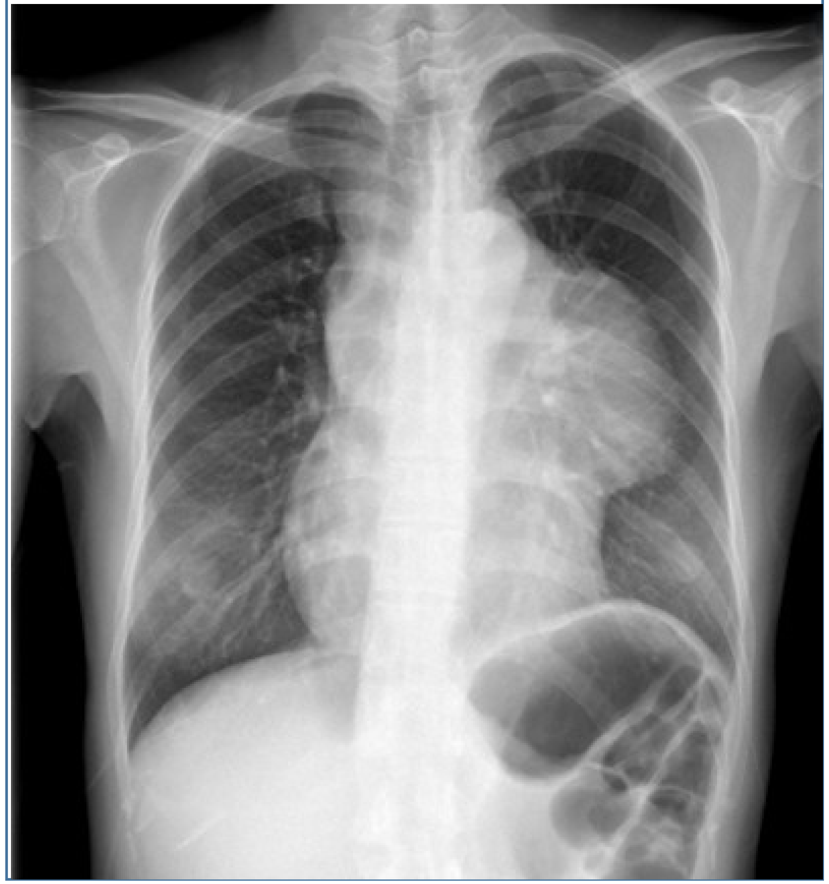
Enlarged, globular heart
Increased convexity in the lower half of the right cardiac border

# Pericadial effusion

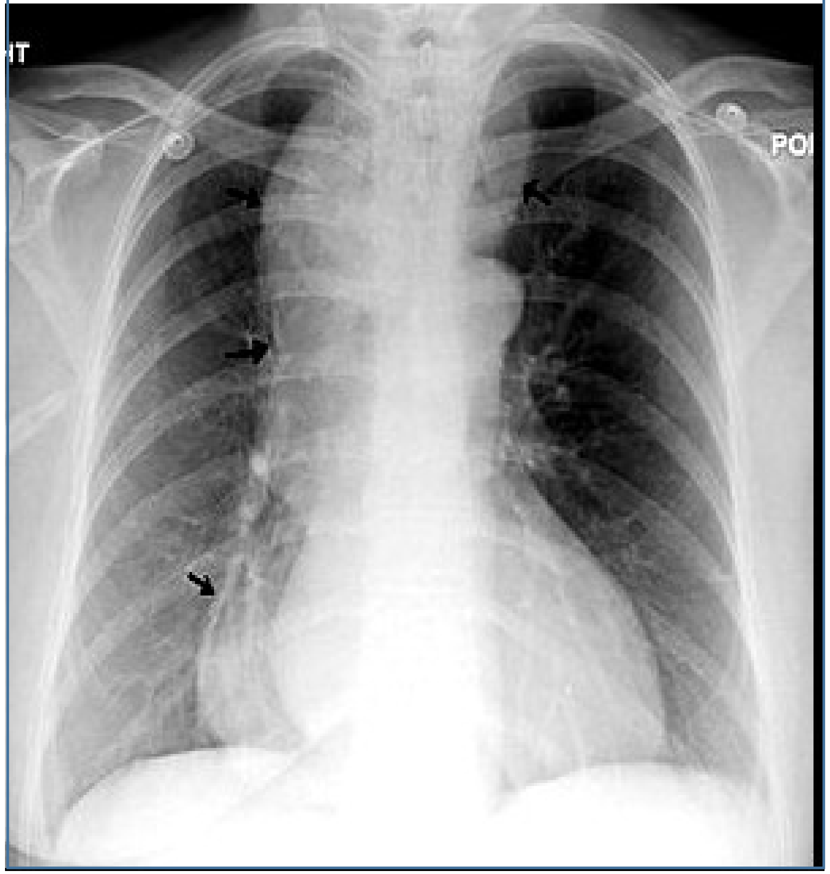


# Mediastinal lesions

**lymphoma •**

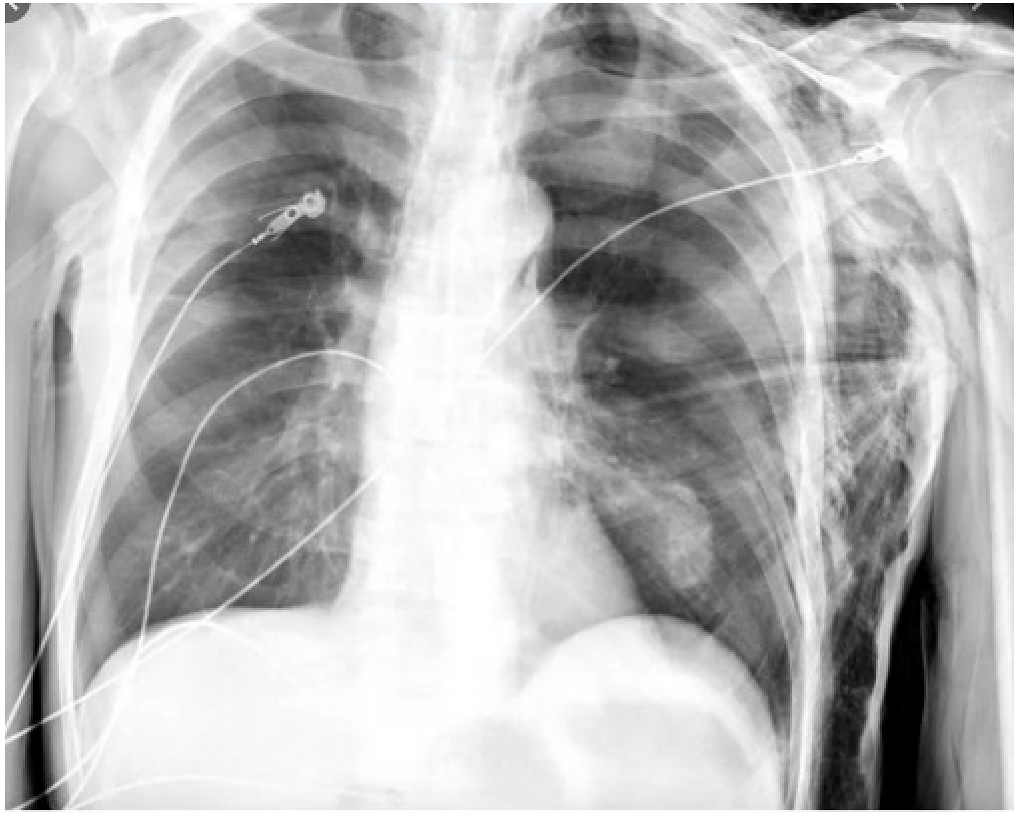


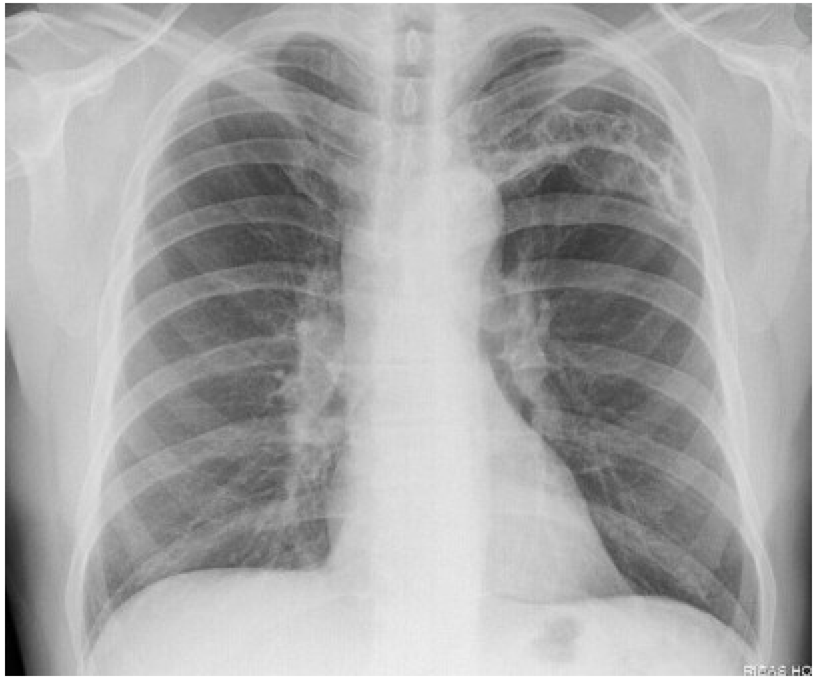
**Esophgeal achalsia**



# Thoracic cage lesions

**Surgical emphysema**

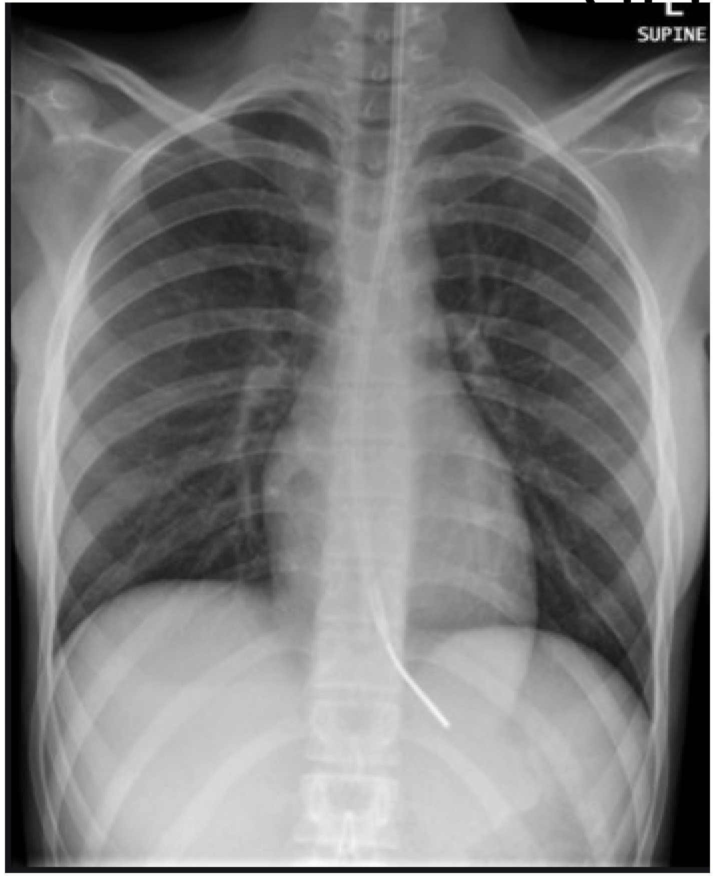




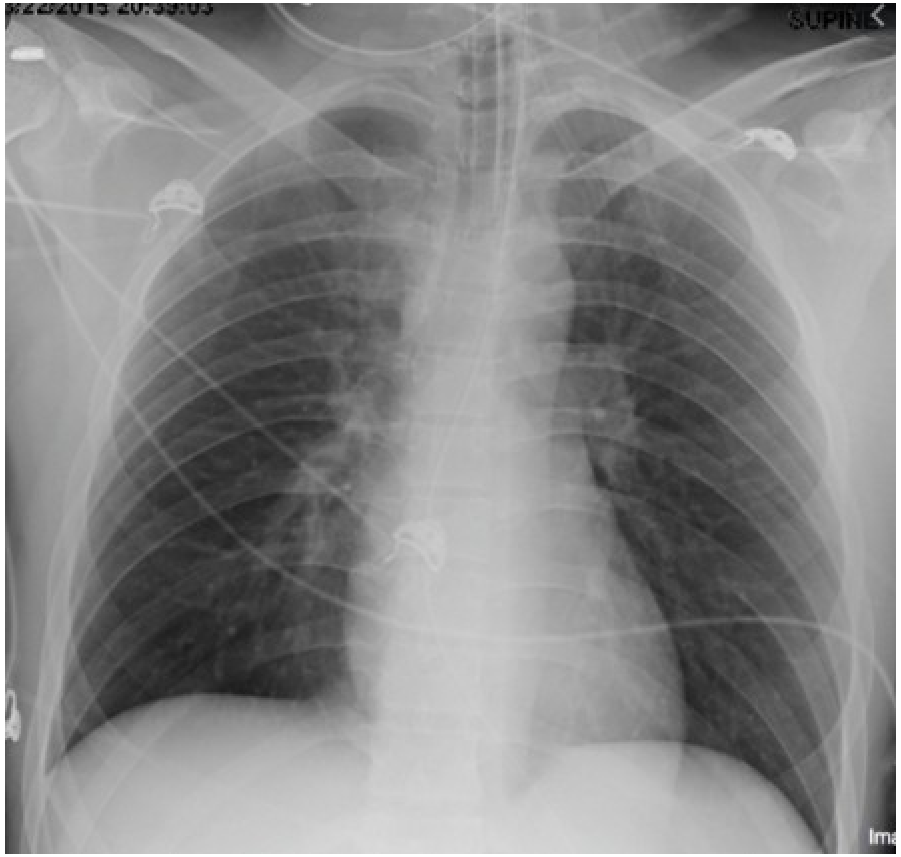
**Left 6th rib expansile mixed lesion**

# Assess chest tubes and lines

- NG tube tip ≥10 cm distal to the GEJ

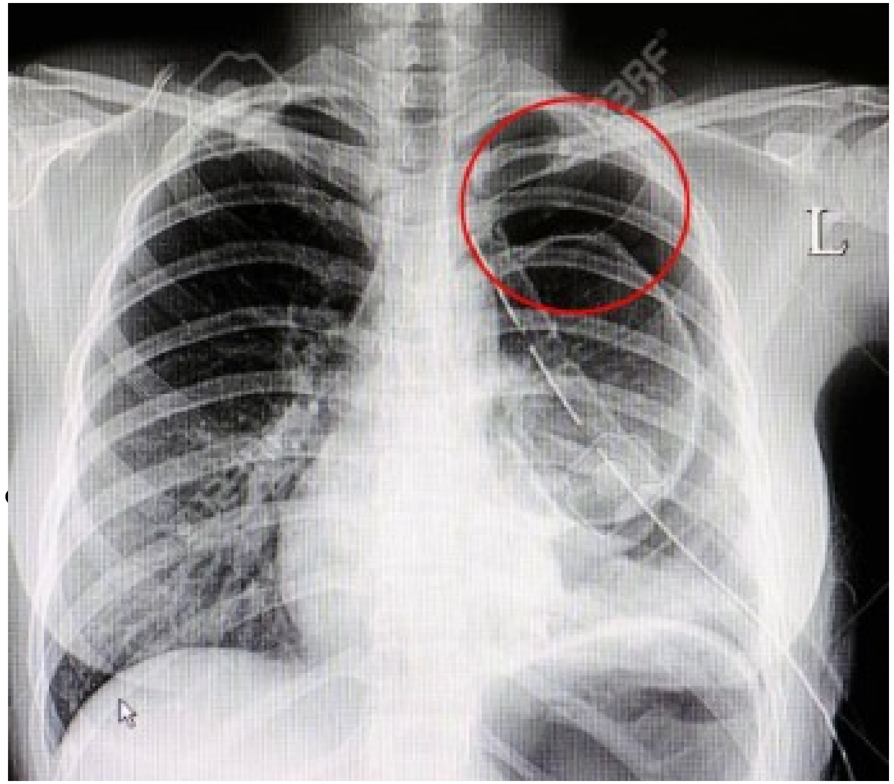


- ETT tip 5 cm above carina



# CHEST TUBE

- If the **chest drainage tube** is to be used in pneumothorax, the **tube** is placed anteriorly near the apex of the lung .(**second intercostal space**)
- If the function of the **tube** is to **drain** fluid, the **tube** is placed posteriorly near the base of the lung (**fifth or** .**sixth intercostal space**)



# Useful Website

https://www.bsti.org.uk/

/www.itnonline.com/content/radiology-publishes-first-case-covid-19-enceph
hy

https://www.bir.org.uk/useful-information/covid-19-resources.aspx

https://pubs.rsna.org/doi/10.1148/ryct.2020200152

https://pubs.rsna.org/doi/10.1148/radiol.2020200642

avirus-covid-19-what-rcr-doing/coronavirus-co
19

hnlotfy@yahoo.com :Email

Thank You